Refuge Notebook

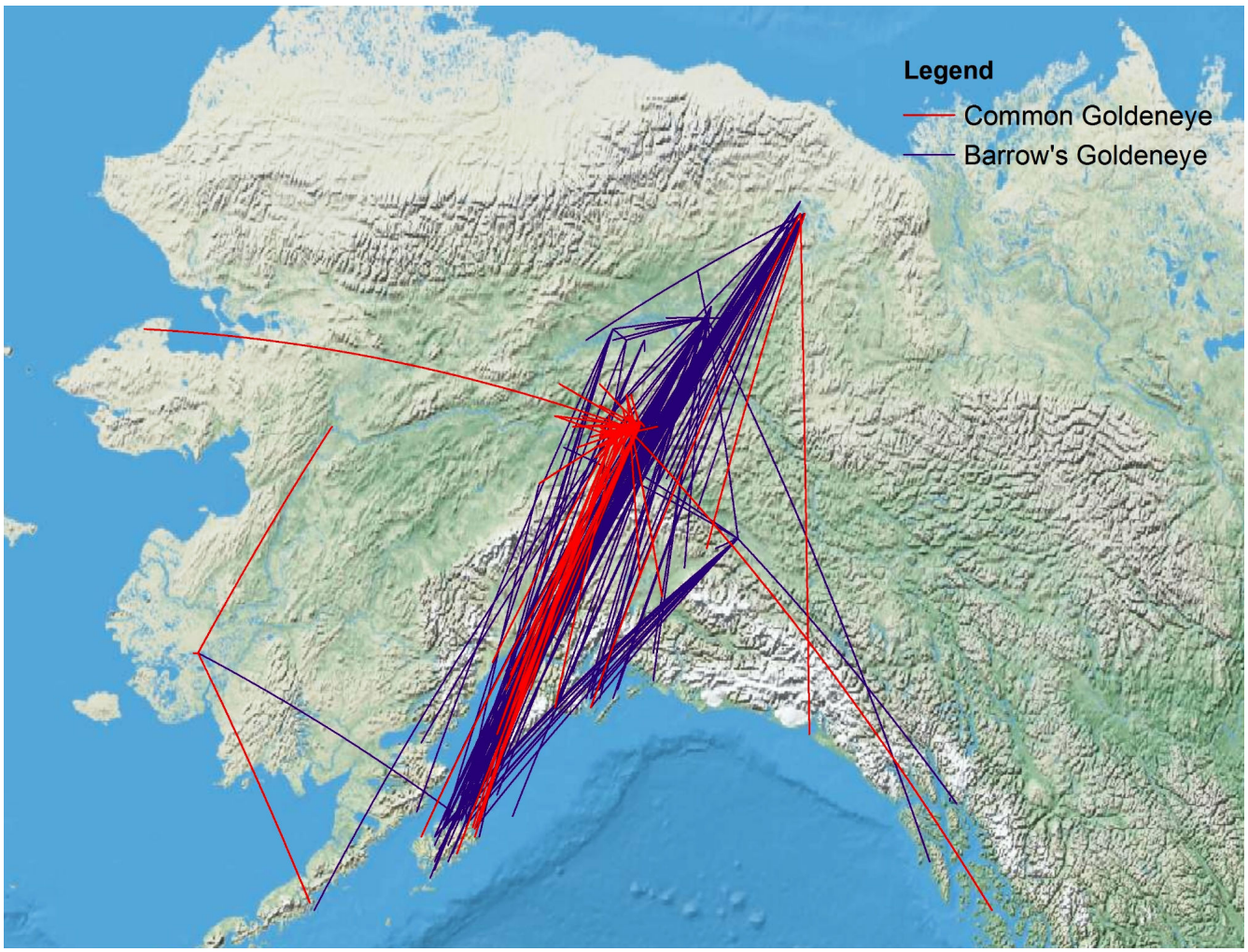
Volume 19 • 2017

USFWS Kenai National Wildlife Refuge

Contents

An eye on goldeneyes

by Todd Eskelin



This map shows that goldeneyes banded in Alaska and the Yukon Territory, Canada, were mostly recovered on the southern Kenai Peninsula and Kodiak (data from the National Bird Banding Lab, Patuxent, MD).

During the past two summers, I have had strange encounters with a duck flying through the woods on my property. Usually in the dusky early morning hours while I was getting ready for work, this duck would zoom through the forest, frequently flaring like it was trying to find a place to land. Several times it even landed on a large tree branch for a moment then zoomed off again. To give you a lay of the land, I am in a fairly wooded area about half a mile from the Kenai River and there are no ponds or swamps that might attract most waterfowl. When the bird finally slowed down long enough for me to get a look, I recognized it was a Common Goldeneye.

Why would it be attracted to my property? Both Common and Barrow's Goldeneye are diving ducks that prefer to nest in tree cavities. I have always tried to leave the snags of dead or dying birch and spruce trees on my property to attract birds, something this female goldeneye apparently found to be quite agreeable. Unfortunately, she has never found the right tree, but she continues to look each summer.

Common and Barrow's Goldeneye nest on the

Kenai Peninsula. They are often found during winter on the Kenai River and Skilak and Tustumena Lakes when open water persists. They are also fairly common in marine areas around Seward and Homer. A quick review of data from the Bird Banding Laboratory in Patuxent, Maryland, reveals that not all of the wintering goldeneyes in south-coastal waters are "ours", but other mysteries are still unresolved.

There are dozens of records of Common Goldeneye banded as nestlings in the Fairbanks area that were eventually harvested during the duck hunting season on the Kenai Peninsula or Kodiak. Barrow's Goldeneye have been banded in several areas including near the Yukon River, Tok, Vuntut National Park in the Yukon Territory, and a handful on the southern Kenai Peninsula near Halibut Cove. For the most part, they all were shot or found dead in the same wintering areas here in south-coastal Alaska.

What the banding data do not reveal are what all the other goldeneyes nesting around the state do in winter as there are only a few places on their nesting grounds where they have been studied. Significantly more research has been conducted on both duck species in British Columbia. There, satellite transmitters tracked their movements as they left the wintering areas where they were initially captured, then to their breeding grounds, then to areas where they molt, and finally back to their original wintering grounds. These studies indicate there is generally little spatial overlap among sub-populations from different breeding areas and wintering areas. So, Fairbanks birds predominantly go to Kodiak and the southern Kenai Peninsula, but very occasionally one will go to southeast Alaska instead.

After the Exxon Valdez oil spill, there was a lot of research conducted on both goldeneyes around Prince William Sound. The studies showed that the birds primarily eat bivalves near shore during the winter. Bivalves are filter feeders, ultimately collecting, storing and transferring whatever toxins are in the water to the birds eating them. Since they filter a lot of water for their own food, they can actually store hydrocarbons in fat tissues at a much higher concentration then they themselves are encountering in the environment. Ten years after the spill, birds from oiled areas were still exhibiting higher concentrations of hydrocarbons and other contaminants than those from non-oiled areas. Evidence of hydrocarbon exposure in goldeneyes eventually declined almost two decades after the spill.

The knowledge we gain from bands and satellite transmitters tells a story that is both good and bad for goldeneyes. These ducks appear to be fairly rigid about where they nest and where they winter. Thus a catastrophic event in our near-coastal waters could be devastating for an entire wintering area and associated breeding sub-population. On the brighter side, we would hope that an event like that would not impact their entire wintering range along the coast from the Alaska Peninsula to northern California, so the population as a whole should be safe from a smaller scale event.

Whether you are a casual bird watcher or an avid duck hunter, we can all agree that even when you're looking down to see where your feet are going through the marsh, you can't fail to hear the whistling wings of a flock of goldeneyes flying overhead at Mach 6. If your goal is to finally recover a duck band while hunting, goldeneyes are probably not your best bet—your likelihood of encountering a banded pintail is four times greater than a banded goldeneye. Your best bet to recover a leg band is still from a Canada Goose, for which you are eight times more likely to encounter one than on both goldeneye species combined.

Todd Eskelin is a Wildlife Biologist at Kenai National Wildlife Refuge. He specializes in birds and has studied songbirds in many areas of Alaska. Find more information about the refuge at http://www.fws.gov/refuge/kenai/ or http://www.facebook.com/kenainationalwildliferefuge.

The Kenai Peninsula's first exotic freshwater snail

by Matt Bowser

Big-eared Radix snails at Beck Lake, September 14, 2016. Credit: Matt Bowser/USFWS.

Sometimes one thing leads to another. It was in fall 2012 as the Alaska Department of Fish & Game and U.S. Fish & Wildlife Service were eradicating exotic northern pike in Stormy Lake that we first found the aquatic invasive plant Elodea on the Kenai Peninsula. Four years later in July 2016, this time as we wrapped up eradication of Elodea from Stormy Lake, we noticed some large, unfamiliar snails.

These turned out to be yet another aquatic invasive species known as the big-eared Radix, the European ear snail, or *Radix auricularia*. Unlike northern pike and Elodea, which are native to some parts of North America, the big-eared Radix comes from Europe. This snail has now spread to New Zealand and much of North America, mostly through the aquarium trade. It is often transported on aquarium plants, on which the snails' inconspicuous eggs easily hitch rides. A single egg of this self-fertilizing species is all that is required to start a new population.

All Alaskan occurrences of *Radix auricularia* have been in populated areas. The only records had been from Fairbanks, where specimens were collected from Smith Lake on the University of Alaska Fairbanks campus and from the Fairbanks International Airport floatplane pond.

Finding *Radix auricularia* in all three Nikiski lakes formerly infested with Elodea is consistent with our suspicion that Elodea, a popular aquarium plant, had

originally been introduced to one of the Nikiski area lakes from someone's fish tank. The two species could have been dumped together and later transported from one lake to another on motorboats. In addition to Stormy Lake, Daniels Lake, and Beck Lake, where Elodea had occurred, we also saw this snail at nearby Suneva Lake.

The big-eared Radix prefers lakes, ponds, and slow-moving streams where it consumes algae and decomposing plant matter. This exotic snail will certainly compete with native freshwater snails and it does serve as prey for some fish species. We do not have much more information about the potential consequences of the European ear snail becoming established on the Kenai Peninsula other than its role as a vector of disease.

Radix auricularia and related snails serve as intermediate hosts for many species of flatworms that infect waterfowl, fish, and mammals—including humans. Thankfully, the species of flatworm that can get into human livers does not appear to be present in our area. Fish and waterfowl are the most commonly infected vertebrate hosts of these flatworms in Alaska.

In waterfowl, the worm's life cycle begins as eggs shed into the water through an infected bird's feces. The eggs hatch into a swimming stage that searches for a snail host. After living in the snail for a while, the worm again enters the water in another swimming stage called a cercaria. The cercaria, upon finding its final host, burrows into the bird's skin and enters its bloodstream, where the flatworm grows and eventually produces eggs.

The swimming cercariae are not especially good at recognizing appropriate hosts, so they will also burrow into the skin of humans, causing a condition called cercarial dermatitis or swimmer's itch. The worms soon die in human hosts, but not before causing irritation to the skin.

A related group of flatworms requires three hosts: a snail, a fish, and a fish-eating bird. The newly-hatched worms first infect a snail. After swimming free of its snail host, the worm penetrates the skin of a fish, where it encysts and remains, causing a condition known as black spot disease. When a bird eats the fish, the worm enters the bird and matures there. Eggs are released into the water through the bird's droppings.

Globally, there have been efforts to reduce populations the big-eared Radix and related snails where these snails are hosts of worms that cause serious diseases in livestock and humans. Most efforts to control the big-eared Radix in North America have focused on preventing further spread.

Radix auricularia is easy to recognize because it is conspicuously larger and broader than most native freshwater Alaskan snails, with a shell growing up to nearly an inch wide. Our other common, large freshwater snails either have a shell that is much narrower or shells that are coiled flat like a coil of rope.

You are encouraged to report this and other exotic species via the UAF Cooperative Extension Service's Citizen Monitoring Portal (http://bit.ly/2ikL8wv), through the Alaska Department of Fish & Game's Invasive Species Reporter (http://bit.ly/2iheCYN), by calling the Invasive Species Hotline at 1-877-INVASIV (1-877-468-2748), or by sending an email to dfg.dsf.InvasiveSpecies@alaska.gov. I would also be happy to look at specimens or photos.

Matt Bowser serves as Entomologist at the Kenai National Wildlife Refuge. You can find more information at http://www.fws.gov/refuge/kenai/ or http://www.facebook.com/kenainationalwildliferefuge.

UPDATE, MAY 2017: DNA evidence from Kenai Peninsula specimens of *Radix auricularia* suggests that these specimens may be Beringian relicts and native, contrary to what had been previously thought. See article at http://www.akentsoc.org/doc/AKES_newsletter_2017_n1_a05.pdf

A Christmas adventure

by Rebecca Uta

Winter sunrise over the Kenai Mountains as viewed from the porch of the Engineer Lake cabin.

Every person has a bucket list to be marked off when they come to this beautiful Land. Our list has always been simple: something Alaskan. As my family hails from the Midwest, we have to admit that back at home there are no mountains that reach beyond the sky, musical dancing night lights above, or the simply awe-inspiring beauty of the local wildlife and vegetation. I do declare that this land is truly blessed with plenty.

As it was coming into the Christmas season, we used this occasion as a reason to reserve four nights at the Engineer Lake Cabin, one of 16 public use cabins on the Kenai National Wildlife Refuge. With everyday activities pulling my family members every which direction, the Cabin was going to be our reconnecting adventure: off grid, unplugged, and remote with peace and quiet.

Besides packing for the simple 4 necessities—food, water, safety and shelter—we planned for comfort and activity. We packed it all up into the truck, drove the 35 miles to Mile Post 9.5 on Skilak Lake Loop Road, and turned left. This short, narrow road to Engineer Lake was lined with dense trees but, as soon as we rounded a corner, ours eyes were filled with a wondrous mountainous view that would be our front yard for the next few days.

Leaving our truck in the parking lot, we loaded our sleds and backpacks, and walked across the beautiful frozen lake towards the Cabin. You don't have to be completely geared out to have an adventure! We walked without showshoes or skis, although they would have been helpful. We had a borrowed sled and a pulk (which I had never heard of before). We knew that we had covered the basics and exuberantly walked into the wilds.

The walk was less than a mile straight across the lake. But with each step further onto the lake, I felt I was shrinking. The lake opened wide, covered in

snow, lined with dense forest, and majestic snow-capped mountains rising around us. Our family footsteps were only specks on the face of the lake. The mountains were tall, blue and white, the sky was grey, and the wind was picking up and stinging our faces with chilled wisps of flurries.

Approaching the cabin, our first impression was that it is indeed a cute, quaint cabin. There was a picnic table, a fire ring, a wood shed packed full. And, by the way, the outhouse was out of sight but not too far away.

It took a second trip to make sure we had all our stuff for 5 days. After we finished with the gear, we exclaimed it was Christmas Day! The first thing to do was to start the stove and get the blazing heat into the cabin. Before our hot breaths disappeared from sight inside the cold cabin, we had coffee on to warm. Percolated coffee is the best.

Next, we put the Christmas lights up over the porch and readied for dinner. The night crept across the already grey sky and we had settled into family games and had some pineapple chicken foil packets. Finally it was dark…incredibly dark. There are no lights for 25 miles in any direction. I experienced complete silence. After we tucked in for the night, I found myself being the last one awake. I was listening to the sound of crackling wood and the rhythmic breathing of my very tired family.

Around 11 p.m., as I tip-toed across the chilly floor to check the fire status, I saw the clouds break ever so slightly through the front door window. The planet Venus shone with such brilliance, this city lady sat in breathtaking awe. I put on my outer layers and crept outside, hoping not to stir a soul. I stood on the porch, inhaling the crisp, clean, cold air, and listened to the wind surge through the spruce trees, and I started singing. I sang O Holy Night, my favorite Christmas Carol. It echoed across the lake and reverberated back to my ears. I stood and smiled. Then in a blinking moment, the clouds covered the stars and left me in darkness bidding me good night. The end of Day One!

Over the next few days, we watched the sun rise, photographed the stars, played cards until the wee-hours, reconnected our family ties, laughed, and enjoyed the Christmas lights! It was a great Christmas adventure, and will be a story for the decades to come. We had no decorations, no presents, no cell phone service, and no major electronic distractions. We sang carols and drank hot cocoa and coffee while we watched the fog ribbons whip across the lake blurring the mountains. We took deep breaths of the cleanest air we had ever taken into our lungs. We truly loved our Alaskan Adventure to the Cabin.

Battery-powered lights helped create our Christmas adventure at one of the public use cabins on the Kenai National Wildlife Refuge.

Each day we wrote a Journal entry in the Cabin Log Book. That is where we left our detailed Christmas chronicle. We really enjoyed reading the tales from previous guests. There were birthdays celebrated here, fish stories, great hikes, descriptions of scat, great and not-so-great poetry, and a sample of what was found… I'll leave that cliff hanger right there. Each person who has come through this same cabin had their own, very personal experience.

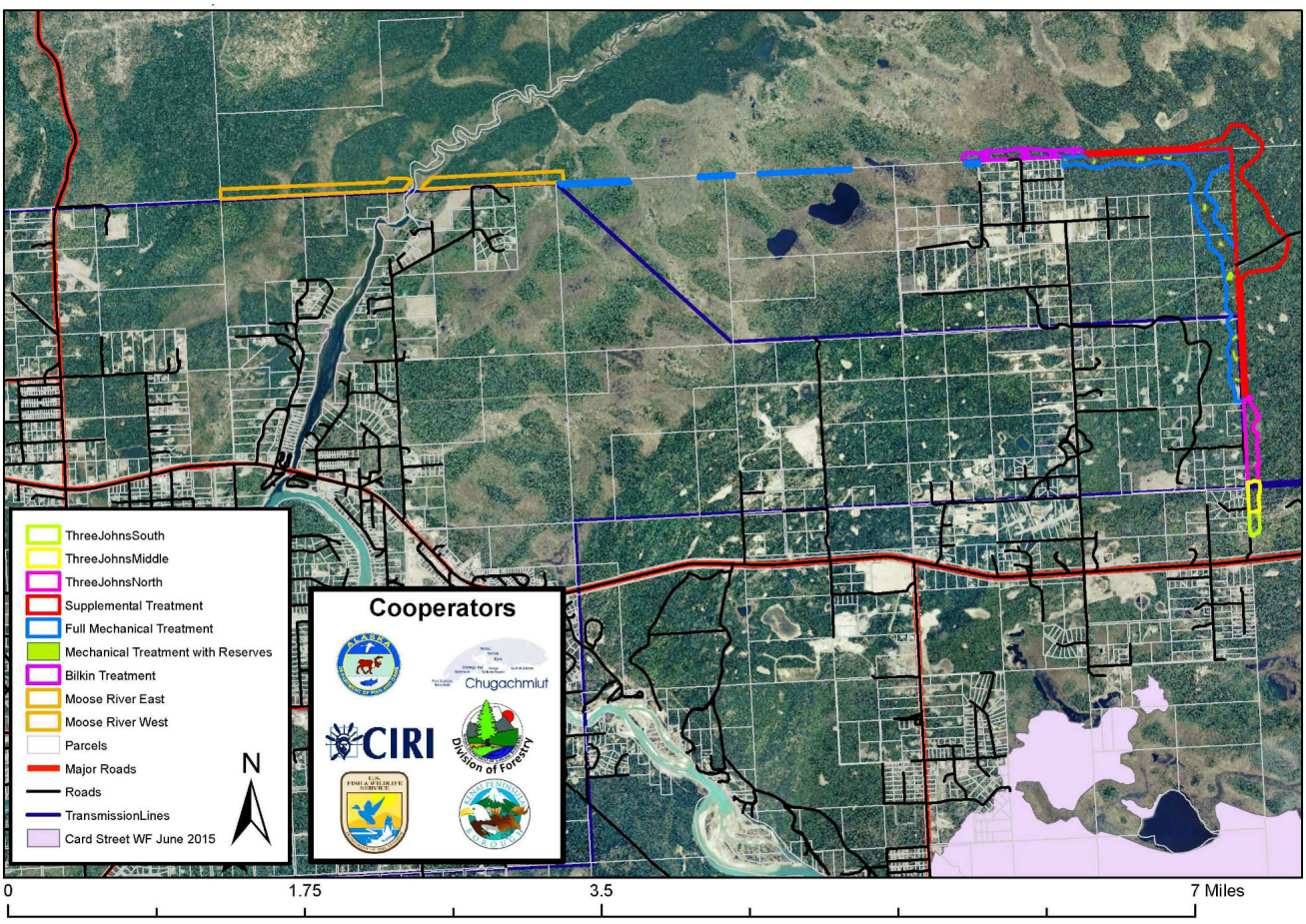
I hope as you read my family's adventure your anxiety eased with the idea of heading out onto the Refuge. The Refuge never closes and will always be here for your recreational use. From our family to yours, we hope you find your adventure, too! Some activities do take pre-planning but, by all means, give the Refuge a call or stop by the visitor center and chat with one of our rangers. To research and reserve a cabin, visit http://www.recreation.gov and search for the Kenai National Wildlife Refuge Cabins.

Take your camera and make some memories!

Rebecca Uta is the Administrative Officer at Kenai National Wildlife Refuge. Find more information at http://kenai.fws.gov or http://www.facebook.com/kenainationalwildliferefuge.

Sterling gets a break with wildfire risk

by Kristi Bulock



The fuel break wraps around the northeast corner of Sterling and straddles the Moose River (credit: KENWR).

Trivia question: What do the 2014 Funny River fire and 2015 Card Street fire have in common? If you guessed both were human-caused and spotted across the Kenai River, that's correct but not the answer I'm looking for. If you guessed that both were controlled (at least in part) by prior vegetation treatments, you are correct! So what does this have to do with the community of Sterling?

As the Card Street fire spread east of Sterling, onto the Kenai National Wildlife Refuge, and then jumped Skilak Lake Road, it intercepted a change in vegetation. The dense and continuous black spruce stand it was burning gave way to an open area Refuge staff had mechanically treated in 2009, and beyond this an area of mixed woods previously treated in 1984 primarily to improve moose habitat. Both treatments changed the fire behavior from a running fire in the tree crowns to a less intense surface fire that firefighters could actually engage with to stop its northward spread. Had those two changes in vegetation type not been there, the fire would have continued to spread east and north, possibly jumping the Sterling Highway and impacting several additional properties northeast of Sterling.

The northern line of the Sterling fuel break before (left) and after (right) treatment (credit: Kenai-Kodiak Area Division of Forestry)

The best available science was utilized to determine the wildfire risk in this area, commonly referred to as the Wildland-Urban Interface. Vegetation types, typical weather scenarios, and the proximity of values at risk are all key inputs for the Interagency Fuels Treatment Decision Support System (IFTDSS). This web-based data integration software provides fire managers with a more efficient and effective framework for fuels treatment planning and analysis. The models rated Sterling as being at a high risk based on the surrounding vegetation's potential to burn, especially along the northeast corner of the community. To reinforce these findings, the Sterling Community Wildfire Protection Plan also identifies this hazard and the need to mitigate associated wildfire risk.

Largely due to the success of previous fuel treatments, the Kenai Refuge received funding to plan and begin implementation of a fuel break near Sterling. The IFTDSS outputs were utilized to prioritize where to start. This was also at a time when the Refuge fire program had reduced personnel. Fortunately, staff from the Kenai-Kodiak Area Division of Forestry (DOF) stepped up to assist. Through a cooperative agreement, DOF will be able to use Refuge funding to plan and treat fuels over the next 3 years. The first of these was just completed in December, and consists of 124 acres on over 5½ miles of ground (see photos). Additional funding was provided by the Alaska Department of Fish & Game (ADF&G).

While the cooperative agreement was being drafted, additional partners joined the efforts: Chugachmiut Incorporated, Cook Inlet Regional Incorporated (CIRI), and the Kenai Peninsula Borough (KPB) joined Kenai Refuge, DOF, and ADF&G. All six cooperators combined resources with the goal of treating approximately 250 acres of vegetation with mechanical treatments, hand thinning, and prescribed fire over the next few years.

The planned fuel break starts on Refuge lands 1/10 mile north of the Sterling Highway at milepost 76, runs north for 2½ miles, then runs west towards Swanson River Road for 6 miles. The fuel break is not contiguous, but is broken into sections on a variety of land ownerships and utilizes natural openings or existing man-made barriers that would already influence fire spread whenever possible. In addition to the 124 acres on CIRI and KPB lands, over 20 acres of mastication and hand-thinned treatments were completed on Refuge lands adjacent to Three Johns Road, with more planned in the upcoming months.

Other than the reduction of wildfire risk to communities, what are the added benefits of these strategically placed fuel breaks? As was mentioned with the Card Street and Funny River fires, they substantially improve the safety of responding firefighters by moving the fire out of the crowns down to the surface therefore reducing the overall fire intensity. Additionally, the decrease in risk helps to increase the decision space for management of new wildland fires, while providing opportunities to utilize fire's role as

a natural process to maintain and improve habitats through the restoration of forest succession. Lastly, these fuel breaks cannot stop a wildfire on their own; it is increasingly important for local residents to employ Firewise principles on their property to fully mitigate the hazards posed by wildfires (often coined the "one-two" punch).

But the story does not end here….anywhere there is hazardous vegetation (fuels) there is a risk of wildfire impacts to lives and property. The Kenai Peninsula Fuel Break Working Group, a subset of the "Interagency All Lands All Hands Action Plan" has been formed to proactively advance this concept for other vulnerable communities on the Peninsula. This group is currently looking westward from Sterling, so stay tuned for more.

Kristi Bulock is the Fire Management Officer at Kenai National Wildlife Refuge. Find more information about the Refuge at http://www.fws.gov/refuge/kenai/ or http://www.facebook.com/kenainationalwildliferefuge.

Oh no, overflow!

by Mark Laker

Despite two feet of ice, a big spider hole formed on Headquarters Lake from the weight of recent snow.

Right next to the headquarters of the Kenai National Wildlife Refuge is a lake, cleverly named Headquarters Lake. With excellent views of the Kenai Mountains, the lake is very popular in the winter time with cross country skiers. In addition to 7.5 miles of premier woodland ski trails, the perimeter (2.2 miles) of the lake is groomed for skate and classic skiing.

A couple weeks ago we had a good dumping of snow, about 6 inches over a couple of days. That Saturday, just after it stopped snowing, I decided to groom the lake. We have two styles of groomers: a roller and the Ginzu. The roller looks like a two-foot diameter culvert that rolls along behind the snowmachine compressing the snow. The Ginzu has a frame with retractable teeth that cut into the snow, break it up, and smooth it to a nice, corduroy surface.

After a good snowfall, I usually snowmachine around the lake to see how deep the snow is while checking for water overflow on the ice before grooming. However, that day I decided to skip the pre-grooming pass. The six inches of new snow should not be a problem for the roller, and I had just skied the day before without incident. After hitching up the roller, I was off. There were six to eight inches of fresh snow packing down nicely.

I was just coming up on the east end of the lake when I felt the snowmachine bogging down. Before even taking a look to see why, I hit the gas. A bit of speed will often get the machine on top of deep snow or over a stretch of overflow. Right after hitting the

gas, I looked down to see water trailing the skis, and turned around to see a growing two-foot pile of slush in front of the roller. Oh no, overflow! I was stopped in my tracks.

Overflow is water on top of ice, and usually under snow, but how does it get there? As snow accumulates it presses down on the ice surface. Where weak spots occur in the ice sheet, water can percolate up and flood across the ice under the snow. While lake ice is being formed, thermal expansion and shrinkage is occurring, fracturing, cracking and weakening the ice. Methane gas from decomposing vegetation can create bubbles in the ice, weakening it. Overflow is a natural process of lake ice formation and very common in Alaska.

In a large overflow event you may see dark sunken areas or a dark spot with several arms coming out like tentacles. These are called spider holes and are often associated with large overflow events. While working on getting unstuck, I noticed a large spider hole about 200 feet away. The arms are created from water running out of the hole and under the snow in several directions. They are typically not dangerous to a skier or snowshoer, as they will be deterred by the large overflow before getting too close. As deep snow is an excellent insulator, overflow conditions may persist for weeks when the temperature is well below zero.

To investigate the forces at play, I wanted a rough estimate of the weight of the snow covering the lake. I was also curious of how much water came out of that spider hole. So a couple days later I went back to the lake and took several snow samples by removing all the snow from a one-square-foot area for weight and water content. I drilled several holes in the lake to measure ice thickness and water temperature. A rough area of the overflow was estimated by driving around on the snowmachine and identifying a rough perimeter.

The average snow depth at the time of the overflow was 18 inches. The average weight of snow covering one square foot of ice was 8.8 pounds. Multiplying this factor by the area of the lake equaled approximately 57 (+/- 15) million pounds of snow!

With snowshoes on and pulling a big sled, I arrived without incident at the spider hole. It was big compared to photos I found online. There was still a four-foot circle of open water in the middle. I didn't see any bubbles coming up, but there were bubbles frozen in the surrounding ice, so gas bubbles could have been a factor weakening the ice. There were bird tracks all over, too—likely they enjoyed the temporary watering and bathing hole.

The area of overflow around the spider hole was approximately a half million square feet. If that area was flooded with 2.5 inches of water it would fill an Olympic swimming pool and then some. The ice thickness was 24 inches in all the holes I drilled and the depth was 5 feet. The water temperature was 35°F.

The warm temperatures this last week have condensed the snow pack by more than half, greatly reducing its insulating capacity. With limited snow insulation, the overflow could freeze with a few cold days and set the lake back up for good skiing.

Mark Laker is an Ecologist with the Kenai National Wildlife Refuge. For ski conditions on Kenai Refuge trails call our office at 262-7021 or find us at https://www.facebook.com/kenainationalwildliferefuge.

2,000 species on the Kenai Refuge!

by John Morton

In 2016, the Kenai National Wildlife Refuge passed a milestone of sorts. Over 2,000 species are now documented on the 2 million-acre refuge including 207 vertebrate animals, 788 invertebrate animals, 501 vascular plants, 181 mosses and liverworts, 368 fungi and 29 unicellular organisms. What helped push us over this second millennial was a concerted effort by Matt Bowser, refuge entomologist, to identify insects as well as the inclusion of 89 non-native species found on the Refuge in recent years.

Biodiversity is given almost mythical qualities by practitioners of Ecology. Diverse systems are more robust and resilient, less likely to collapse in response to something like a new insect pest. Unknown species may harbor medicinal attributes…perhaps the cure for cancer. Biodiversity also provides other ecosystem services to humans such as nutrient cycling, carbon sequestration, pest regulation and pollination, and the sustaining of agricultural productivity.

But, frankly, biodiversity is really about Life. After all, Earth is nothing more than our Ark, upon which we try our best to keep at least two of every living thing. Whether you believe species are nodes in an evolutionary process or created by a higher being, just stop and really consider how amazing it is that a tiny bundle of DNA produces life that is uniquely adapted for a niche defined by space and time, and constrained by interactions with other species. Edward O. Wilson, famed Harvard University professor, said "We should preserve every scrap of biodiversity as priceless while we learn to use it and come to understand what it means to humanity."

How many species are there? A 2011 paper published in the journal *PLOS* used statistical modelling to estimate there are likely 8.7 million species (not counting bacteria) in the world. Unfortunately, less than 1.8 million species have actually been identified.

The good news is that between 15,000 and 18,000 new species are identified each year, about half of which are insects. The bad news is that it will take about 5 centuries to finish inventorying the Ark at this rate!

What's uncomfortable about this low rate of identification is that somewhere between 0.01 and 0.1 percent of species go extinct each year, which translates to 900—9,000 species lost annually! So for every two species discovered by scientists, one disappears forever. Two steps forward, one step back.

What's amazing is that even today, megafauna are being discovered. Consider that a new giant tortoise species was discovered last year in the Galapagos Islands made famous by Charles Darwin, the father of evolution.

In recent years, four new species were discovered on the Kenai. A 2014 article in the Annals of the Entomological Society of America describes two new species of parasitic figitid wasps, *Phaenoglyphis kenaii* and *Alloxysta vicenti*. A new species of smut fungus (*Anthracoidea kenaica*) and two moss species (*Sphagnum kenaiense*, *S. bergianum*) were first collected on the Kenai.

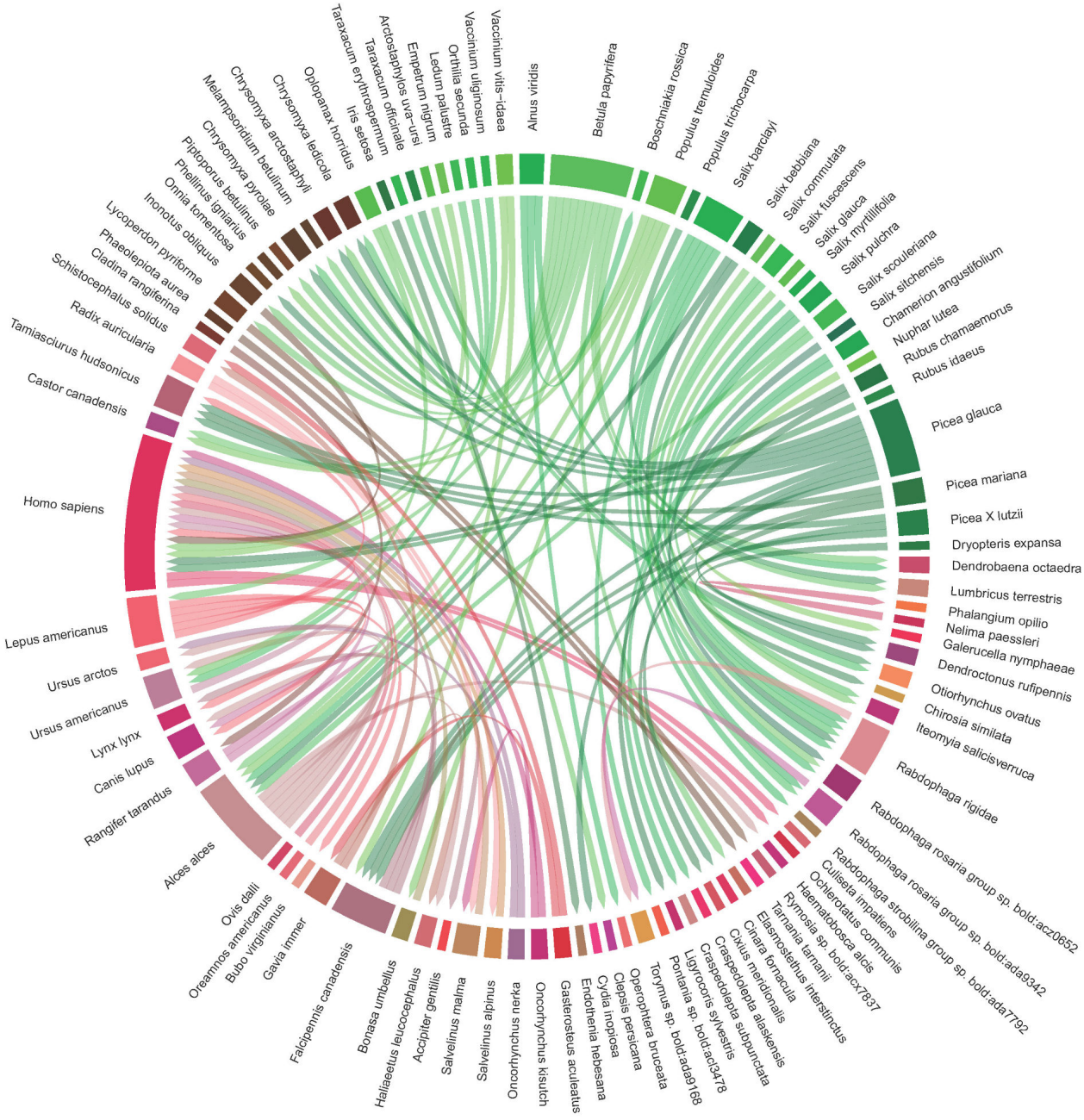
And biodiversity can even be unexpectedly high on the Kenai when you look closely. Rob DeVelice, recently-retired Forest Service ecologist, identified 28 lichen species growing on a single Lutz spruce that was cut down off the Seward Highway and sent to Washington D.C. as the Capitol Christmas Tree in 2015. Kenai Refuge biologists have found as many as 105 plant and animal species associated with 100-meter-square plots surveyed in 2004 and 2006.

We continue to inventory the Refuge's biodiversity. In recent years, we've begun identifying species through their DNA using Next Generation Sequencing. This analytical method spits out a barcode, a fragment of base pair sequence, which is then matched up with sequences from species previously identified by more conventional morphological means. To help this along, we've worked with Derek Sikes, the museum curator at the University of Alaska Fairbanks, to barcode almost half of the 8,300 arthropod species known for Alaska. This success story was recently published in the journal *Genome*.

With our new ability to rapidly identify otherwise cryptic species with genetics, we've begun thinking seriously about doing an exhaustive (not just comprehensive) inventory of species. This is sometimes called an All Taxa Biodiversity Inventory (ATBI), originally pitched by Dan Janzen, an evolutionary ecologist at

the University of Pennsylvania. Biologists at the Great Smoky Mountain National Park started the first ATBI in 1997, where they have since documented more than 15,000 species, and believe as many as 55,000 more taxa may live there.

Biodiversity decreases as you move away from the equator toward the poles, so it may be more fitting to look at the Swedish Taxonomy Initiative, another ATBI, but one that is at the same latitude as the Kenai Peninsula. There, they expect to eventually document as many as 50,000 species of multi-celled organisms, quite a bit more than we've documented to date. Although Sweden is 18 times larger than the Kenai Peninsula and so should have greater biodiversity, it does suggest we still have much work to do.



Why biodiversity matters: A food web showing 110 relationships among 98 species found on the Kenai Peninsula. Browns are fungi, reds are animals, and greens are plants. Note how humans (Homo sapiens) *are part of our web.*

It makes sense we should continue down this path. Kenai Refuge shares a legislative purpose with the other 15 Alaska Refuges to "conserve fish and wildlife populations and habitats in their natural diversity." The 1980 Alaska National Interest Lands Conservation Act further defines "fish and wildlife" as "any member of the animal kingdom including without limitation any mammal, fish, bird, amphibian, reptile, mollusk, crustacean, arthropod or other invertebrate." That's a tall order, but one that's well worth the effort.

Dr. John Morton is the supervisory biologist at Kenai National Wildlife Refuge. Find more information about the Refuge at http://www.fws.gov/refuge/kenai/ or http://www.facebook.com/kenainationalwildliferefuge.

New wildlife biologist lands in Kenai Refuge

by Dom Watts

Dom Watts fits a cow moose with a GPS radio-collar for a study of moose reproduction and calf survival on the Alaska Peninsula.

As I navigated the icy roads through Turnagain Pass a couple weeks ago in a borrowed car filled with totes and duffle bags, I couldn't help feeling excited about my new position as a Wildlife Biologist for the Kenai National Wildlife Refuge. It was fun to think that these spectacular mountains around me would be my home for the foreseeable future. I thought about driving through the pass for the first time, some 15 years ago, when some college buddies and I had made the trip down to Homer for halibut and combat fishing on the Russian.

After that first trip up to Alaska, I remember looking at maps of the Alaska and realizing that I just hadn't seen enough of the state. With that realization came another—that I needed to actually live in Alaska to truly experience it. Although I loved my job as a guide in northern New Mexico and enjoyed the work I'd been doing helping with bighorn sheep and black bear projects, I immediately started applying for biologist jobs in Alaska.

I got lucky and landed one in Galena, on the Yukon River, where I worked as a seasonal biologist for the

Koyukuk/Nowitna National Wildlife Refuges. While working on a variety of waterfowl, moose, and other projects I gained much valuable experience. More importantly, I gained a genuine appreciation for working with wildlife in the vast and intact ecosystems of Alaska.

After graduating from New Mexico State University with two Bachelor's degrees, one in Fisheries Science and one in Wildlife Science, I accepted a graduate position at Texas A&M University where I studied deer in the Florida Keys. Although the weather was certainly nice in the Florida Keys, I found that I was always looking north toward the 'Great Land'. Upon finishing up my master's degree, I took a position with the Alaska Peninsula and Becharof National Wildlife Refuges in southwest Alaska as the lead mammals biologist.

I worked on the Alaska Peninsula for over a decade where I studied wolves, caribou, moose, and other mammals. Some of my favorite work in southwest Alaska included studies of wolf and bear predation on caribou and moose calves, and wolf use of alternate prey such as salmon and marine mammals. I also conducted studies of moose habitat use, migration, reproduction, and calf survival. These and several other studies have provided me with a good understanding of ungulate population dynamics and predator-prey relationships that I hope to put to good use here on the Kenai.

I have also worked with a variety of other wildlife including mesocarnivores such as fox and wolverine, swans and other waterfowl, shorebirds, and a variety of small mammal species including shrews and bats. I've also been lucky enough to lend other biologists a hand with their studies including traveling to Kodiak National Wildlife Refuge to capture and radio-collar brown bears, and to Hawaii to aerial net-gun Mouflon sheep and feral cattle. I've also taken time away from work to help develop survey methods for Marco Polo sheep and ibex in central Asia, where I still travel each year.

I loved living in Bristol Bay, particularly because I'm an ardent fly fisherman, so the decision to move was not made lightly. Still, moving to a new place always presents opportunities to learn new things and challenge myself and I think that the decision to relocate was a good one!

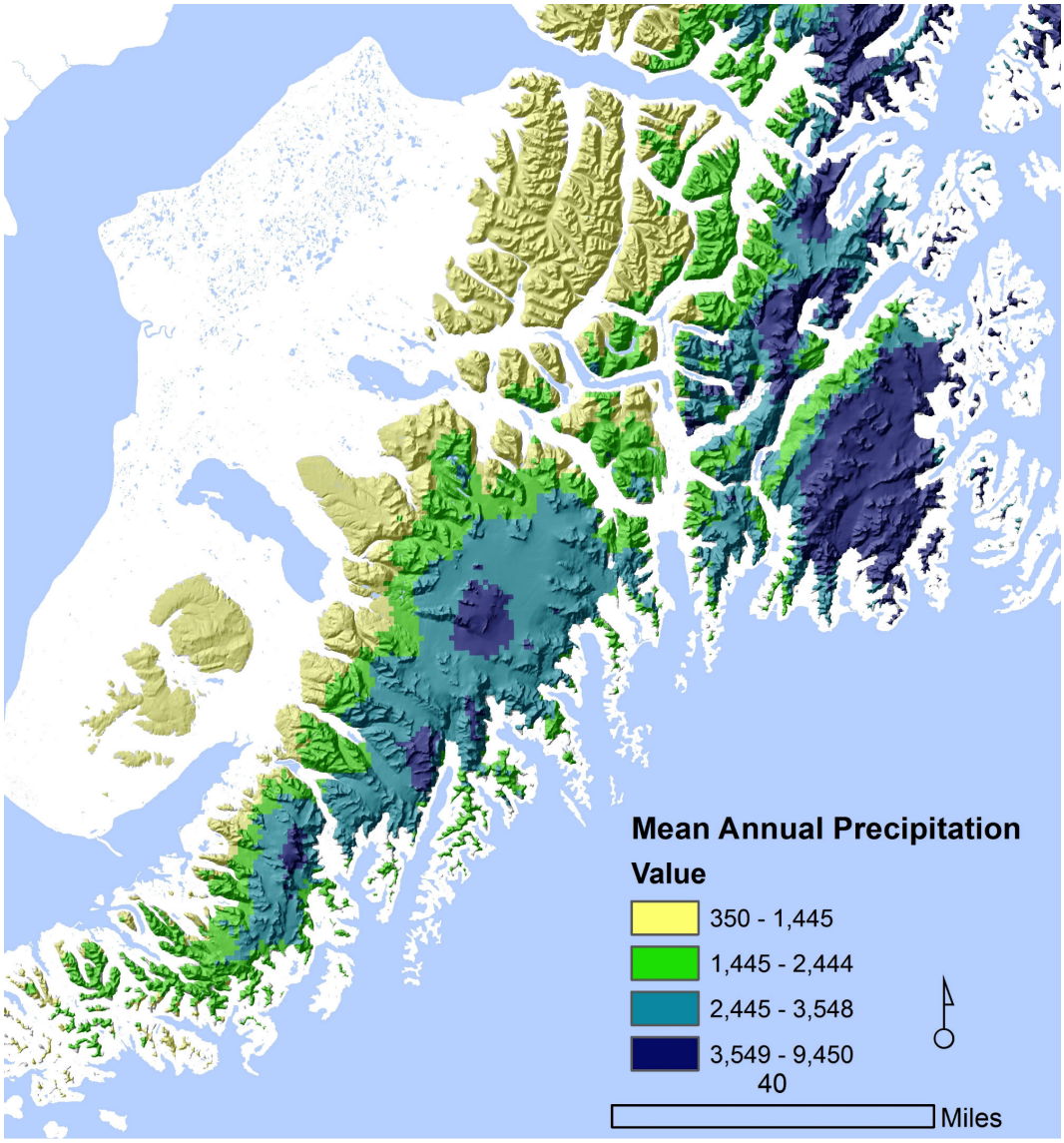
Since my arrival here in Soldotna a couple weeks ago I've already been busy working cooperatively with the Alaska Department of Fish & Game to complete aerial surveys to estimate moose numbers on the southern Kenai Peninsula. It's been a great opportunity for me to meet new people and to start learning this new area. As a pilot, I'm also very excited about getting to fly around in some new country, both as part of work and for fun!

I am proud to work on our nation's public lands, helping to manage and conserve our state's resources for the continued benefit of both wildlife and people. I look forward to learning more about this remarkable area and to settling into this great community.

Dominique Watts is a new wildlife biologist at the Kenai National Wildlife Refuge. Find more information about the refuge at http://kenai.fws.gov or http://www.facebook.com/kenainationalwildliferefuge.

Rain shadows create diverse (and changing) alpine habitats

by Dawn Robin Magness



Annual precipitation varies in alpine habitats above 1500 feet on the Kenai Peninsula due to the effects of rain shadows. Precipitation amounts in millimeters and extrapolated from weather stations by AdaptWest (https://adaptwest.databasin.org/).

The Kenai National Wildlife Refuge is often described as "Alaska in miniature" because of the variety of habitats that occur here. On the Kenai Peninsula, we live where two biomes meet. The eastern half of the Kenai Mountains has a climate similar to the temperate rainforest that spans the Oregon Coast and rainy Southeast Alaska, finally reaching its northwestern limit here. On the eastern side, rubber boots are

needed to protect soggy feet.

On the western side, the Kenai Mountains mark the southern extent of the boreal forest. The boreal forest is described as the crown of the continent because it forms a green band below the arctic that extends fully across Canada into Alaska. This side is drier, with colder winters and warmer summers.

Our mountain habitats are diverse because of the climate gradients that occur as the temperate rainforest and boreal forest biomes mingle. Additionally, because we live on a peninsula that juts into the Gulf of Alaska, our mountains create rain shadows. Rain shadows occur when prevailing winds blow across the ocean and up a mountain slope. As the moist air moves upward in elevation, the air cools and condenses into precipitation. Once over the mountain top, the now dry air descends and is warmed causing that side of the mountain have a warmer and drier environment.

The topographic diversity in the Kenai Mountains also contributes to the diversity of habitats. The highest peaks are over 6,600 feet. Uplift from tectonic plates and glacial scouring carved out our mountain landscape. Depending on the aspect, elevation, and shading from surrounding peaks, different locations get more—or less—warmth from the sun.

Ice fields occur at high elevations and give way to alpine tundra that is the dominant vegetation type above 3000 feet. Forests generally do not form above 1500 feet. In the zone between tundra and forest, a complex matrix of shrubs, tundra and stunted mountain hemlock fills the available microhabitats.

On average, the Kenai Peninsula is warmer than it was in the past. All across Alaska, trees and shrubs have been documented growing at higher elevations where it was too cold for them to survive or germinate in the recent past.

Roman Dial, a professor at Alaska Pacific University in Anchorage, has published studies that document how a warming climate is changing the alpine habitats in the Kenai Mountains. Dr. Dial has measured shrub habitats moving upward at a pace of 92 feet per decade since the 1950s, which almost keeps pace with his calculations of the velocity that climate conditions are changing. In other words, the growing season temperatures in the mountains today would be similar to the temperatures experienced about a topographic map contour lower just 10 years ago.

Trees are also moving upward in elevation, but at the slower pace of 36 feet per decade and mostly on North-facing slopes. Mountain hemlock and white spruce are colonizing alpine tundra at higher elevations, but depend on both warmer temperatures and enough water for their seeds to germinate and grow. Northern aspects are more likely to have enough moisture.

At elevation below tree-line, the mosaic of habitats is becoming woodier too. Alpine patches are filling in with shrubs. Open woodland and shrubby areas are transitioning to forests.

In the summer, I enjoy hiking up into the alpine. I like the vistas. I also like to imagine where seeds of spruce and hemlock may germinate in the future.

Dr. Dawn Robin Magness is a landscape ecologist and Fish & Wildlife Biologist at the Kenai National Wildlife Refuge. Find more information at http://www.fws.gov/refuge/kenai/ or http://www.facebook.com/kenainationalwildliferefuge.

The scientific basis for hunting

by John Morton

Dr. Paul Errington defined compensatory mortality, which is the basis for modern harvest management (photo credit: e-library Iowa State University).

In the world of wildlife and fisheries management, the death of an animal does not always directly equate to one less animal in the population. For the animal that died, this effect on the population demographics is moot. As Kurt Vonnegut wrote in the 1961 novel *Mother Night*, "when you're dead, you're dead".

But for the larger population, the timing of the death (and the sex and age of the individual) is everything. Wildlife biologists and managers distinguish between compensatory versus additive mortality in a population. Disease, starvation, predation, and even cannibalism or infanticide can be sources of natural mortality in wild populations. One of the effects of human intrusion into a natural landscape is incidental mortality of wildlife caused by birds striking windows, raptors electrocuted on utility transformers, bears killed in defense of life or property, or vehicles colliding with moose. These human sources of mortality are generally considered additive to natural mortality.

However, when it comes to game species, harvest by humans for recreational or subsistence hunting and trapping can be a source of additive or compensatory mortality depending on when it occurs. For many game species, young-of-the year disperse in the autumn, temporarily exceeding the carrying capacity of their habitats. This is true for many species with high reproductive rates and short life spans such as spruce grouse and snowshoe hares. As fall turns to winter, their broods and litters are fated to die by one means or another so that populations are sustained around the carrying capacity of their habitats for the remainder of the year.

And because these young can be considered a "doomed surplus", it is a good time for us to harvest them for human consumption. Paul Errington, a now-deceased Professor of Zoology at Iowa State University, was the first to define hunting during this time of surplus as a form of compensatory mortality. By that, Dr. Errington meant that the following year's reproductive rate would increase or decrease to compensate for variations in populations, a form of density-dependent regulation. His observation of an inverse relationship between density and the proportion of young is, as Aldo Leopold put it, "the scientific explanation of why game can be hunted at all".

In contrast, excessive or ill-timed hunting may be additive, cumulatively adding to rates of natural mortality with the result that populations can be reduced below their habitat's carrying capacity.

Errington is considered one of the giants in Wildlife Management, both a mentee and colleague of Aldo Leopold, and a recipient of The Wildlife Society's Aldo Leopold Award in 1962. An ardent hunter and trapper, he also authored over 200 scientific articles and four books. He studied the effects of predation and disease on muskrat demographics for decades, his insights into their life history from 30,000 hours of field observations ultimately redefining the role of predation and establishing the basis for modern harvest management.

He wrote that people confuse "the fact of predation with effect of predation". By that, he meant that an act of predation does not necessarily result in a reduction in the prey population. Here on the Kenai National Wildlife Refuge, a young-of-the-year fool's hen eaten by a coyote in the fall or shot by a hunter may not translate to one less spruce grouse the following year. "Predation", he wrote, "belongs in the equation of Life."

And so the father of the theory of compensatory mortality, the very basis for contemporary harvest management, became a vocal critic of predator control during his day. Errington also pushed back on people who spoke of some wildlife being pests if they were not for human consumption or some other human resource. In a 1947 essay entitled "A Question of Values", published in the *Journal of Wildlife Management*, he wrote "Let it be understood that among so-called vermin are some of our most beautiful and valuable wild creatures."

Having earned my undergraduate degree in Wildlife Ecology from the University of Wisconsin at Madison, in the department started by Aldo Leopold from which Paul Errington earned his Ph.D., I first learned about Errington four decades ago. But I'm only now really beginning to appreciate how ahead he was of his time.

I encourage you to explore his thinking on your own. His classic 1957 book, *Of Men and Marshes*, was reprinted in 1996 and is an easy read during these long (but waning) winter nights.

Dr. John Morton is the supervisory biologist at Kenai National Wildlife Refuge. Find more information about the Refuge at http://www.fws.gov/refuge/kenai/ or http://www.facebook.com/kenainationalwildliferefuge.

Making a more sustainable landscape on the Kenai Peninsula

by John Morton

80 or so workshop participants came together this past week to discuss more collaborative ways of managing public lands on the Kenai Peninsula.

If you're a Kenai Peninsula resident, here are some important events that I'm guessing you don't know. Do you know that management of public lands on more than half of our 6-million-acre peninsula is currently being updated? Chugach National Forest is in the middle of revising its Forest Plan. The Alaska Department of Fish and Game is revising its management plan for Kachemak Bay and Fox River Flats Critical Habitat Areas. The draft revised management plan for Kachemak Bay State Park and State Wilderness Park is expected to be out for public review on April 24th.

Closer to home for many of you, the revision process for the Kenai Peninsula Borough Comprehensive Plan is just getting started. And did you know that there has never been a land management plan for the 130,000 acres owned by the Borough? That, too, is scheduled to begin development in the near future.

Only 4 percent of the Kenai Peninsula is in private

ownership, carved into over 55,000 parcels. Another 8 percent is owned by Native villages and corporations. So you should hope (and expect as a citizen) that the various agencies are doing their best to manage the 88 percent of the peninsula that is held in the public trust.

All of this and much more was discussed this past week at a workshop entitled "Land Management on the Kenai Peninsula: Opportunities to Work Across Boundaries". Over 80 representatives from federal, state and local land management agencies, Native corporations and villages, and partnerships met at the Solid Rock Bible Camp to share information and discuss ways of doing business better. Mayor Mike Navarre opened the workshop by sharing his perspective on planning processes that had gone well…and others not so well.

But there are some landscape-scale issues that simply know no boundaries, and this is the role that interagency and citizen-driven partnerships fill. The All Lands – All Hands partnership strategically places fuel breaks around communities to help stop wildfires that might not otherwise stop when they burn to the boundaries of the Kenai National Wildlife Refuge. The Kenai Peninsula Fish Habitat Partnership works to protect, maintain, restore and enhance fish habitat wherever it may occur, helped by the Partners for Fish & Wildlife Program and the National Fish Passage Program. Interagency partners in the Kenai Peninsula Cooperative Weed Management Area work as a team to eradicate and contain invasive plant species.

The Kenai Mountains to Sea partnership seeks to sustain riparian corridors along 20 streams that comprise half of the 1,800 miles of anadromous waters on the peninsula. These 20 streams are "interjurisdictional", meaning that their headwaters are protected within the Federal conservation units but they flow through what is sometimes a gauntlet of private lands to get to the sea.

An advisory board composed of agency representatives, user groups, and citizens helps State Parks manage the Kenai River Special Management Area. The Stream Watch Volunteer Program, jointly administered by Chugach National Forest and Kenai Watershed Forum, works over multiple jurisdictions to help educate the public, enforce rules, and clean up the Kenai River.

A nonprofit organization is working to promote bike trails between trailheads along the Seward and Hope Highways as a way of appreciating the Kenai Mountains-Turnagain Arm National Heritage Area. The Friends of Kachemak Bay State Park is developing the Kachemak Bay Water Trail so kayakers (and other boaters) can circumnavigate the multi-jurisdictional shoreline of Kachemak Bay.

There were some cross-boundary issues that still need champions. Consider our current need for a more strategic view on future development of the peninsula's road network. Consider our rapidly evolving need to begin planned adaptation to a warming climate.

If you don't know about some of these management plans for public lands or partnerships, you're not alone. There were more than a few professionals at this forum who were surprised at how much really is going on. One idea floated was to maintain a website where all plans and projects could be posted.

Another idea was to create a library of available spatial data, perhaps called the Kenai GeoHub, where links to (or contacts for) important data sets for the Kenai Peninsula could be maintained. Along those same lines, it was agreed that a second workshop would be held this fall to discuss data needs common to all or most land management agencies and organizations.

Perhaps the most important outcome was the general agreement that a gathering similar to what occurred this past week should happen annually. This kind of collegial networking and information sharing is critical to create and sustain truly collaborative efforts among public agencies. Frankly, we'll need to pool our resources and work smarter as local, state and federal budget forecasts seem slim over the next few years.

Lastly, I encourage you to engage in the public process for managing lands that all of us own!

Dr. John Morton is the supervisory biologist at Kenai National Wildlife Refuge. Find more information about the Refuge at http://www.fws.gov/refuge/kenai/ or http://www.facebook.com/kenainationalwildliferefuge.

March Madness—Alaskan style

by Todd Eskelin

This pair of Trumpeter Swans waits for the ice to melt at the Kenai Flats in early April, 2006 (Todd Eskelin USFWS).

As many eyes turn to their television sets this week to watch the 7-10 match up between the Gamecocks and the Golden Eagles or the possible battle between the Jayhawks and the Eagles, Alaskans look over their shoulder and wonder "have we made it through the worst of it?" The daylight is lengthening and we are seeing the tell-tale signs of the S word that nobody dare utter. You look at the jagged south facing berms on the side of the road and sure enough they are shrinking at a considerable rate, while the north facing side looks smooth and the same as it did last week, last month, or even 2 months ago.

The resident bird species recognize the change in photoperiod too and they are not afraid to say it. Anyone with bird feeders may notice when black-capped chickadees start calling with a longer drawn out cadence as the sunlight reaches your yard. They often start emitting a series of single whistles repeated over and over as the breeding season approaches. This is a notable shift from the "chickadee-dee-dee-dee" calls we have been hearing all winter. The nuthatches at my feeder have even started doing some pre-nesting singing and increased the rate of the constant backup alarms calls that they are incessantly broadcasting. A pair of Bald Eagles is bickering loudly outside my window as I write. Presumable the nest repair stick that was collected did not make the grade and a "discussion" has ensued.

The thing that is fascinating about year round resident bird species versus migrants is that residents are already here and many are willing to take advantage of an early nesting opportunity if the weather looks favorable. This does not always work out in their favor. I watched a Common Redpoll in Fairbanks one year that nested during a warm stretch in April only to have several inches of snow fall one night. She sat there in that nest for 2 days with an inch of snow on her back trying to keep her eggs warm, before abandoning the nest and starting over once it all melted.

The "madness" of March is that many species are trying to survive the last stretch of winter, but at the same time they need to fatten up and prepare for the upcoming breeding season. We have long known that health can be one of the biggest factors for reproductive success in birds and four-legged animals. Inadequate fat stores can reduce pregnancy rates, egg laying success, and survival of young after hatching or birth.

Locally, Trumpeter Swans that overwinter or arrive early in spring before ice-out must find ways to feed themselves and actually put on fat to successfully nest and raise young in the coming months. That means undisturbed access to open water and aquatic vegetation is critical during this period. Low fat stores do not bode well if they are to be successful in nesting, laying eggs and raising a brood.

Local birds are not the only ones that are evaluating the situation towards the end of winter. Red squirrels are becoming more active and with little new food available, they are reliant on whatever stores they put away last fall. This is often comprised of dried mush-

rooms and a huge pile of spruce cones. The question is did they stock pile enough before new calorie sources are available in the spring.

The concept of food storage for the long winter is not unique to the wildlife of Alaska. The Dena'ina and Ahtna Athabascans of Southcentral Alaska constructed shallow holes or pits for storing fish for the winter. These caches were often lined with grass or birch bark and layered with grass and fireweed to keep fillets separated. They were an essential part of having enough resources to survive the winter until more food presented itself to them in the spring.

For Alaskans living in the bush, this is the time of year when they start taking stock in what resources they have left to feed the family until new resources are available. This is a straight up indictment on how well you and your community stored in the fall and early winter and how well the land provided for you. There is little opportunity for fish and you may or may not have access to moose or caribou depending on seasons, migration timing and such. There are no berries in March and migrating birds will not be back for a few more months so options can be quite limited.

March is a time in native culture where the true spirit of sharing and community are highlighted. It is much easier to share your resources when there is plenty to go around and your cache is full. But sharing when your cache is depleted—that is the true meaning of community.

Todd Eskelin is a Wildlife Biologist at the Kenai National Wildlife Refuge. He specializes in birds and has conducted research on songbirds in many areas of the state.

A brief history of mountain goat population management on the Kenai Peninsula

by Dom Watts

Mountain goat populations may be increasing on the Kenai Peninsula (credit: National Park Service).

Mountain goats are found throughout the Kenai Mountains, including lands managed by the Kenai National Wildlife Refuge. While mountain goats have been introduced to Kodiak Island, the Kenai Mountains represent the westernmost extent of the species' natural range in North America. Mountain goats occur at their highest densities in coastal areas, but they also occur at lower densities throughout the interior Kenai Mountains. Although mountain goats are primarily managed for sport and subsistence hunting, they are also important for recreational viewing and photography, and to sustain the structure and function of alpine habitats.

When the first western trappers and miners reached the Kenai Peninsula, they hunted mountain goats for their meat and valuable hides. Of course, Alaska Native communities had been hunting goats in the area for centuries. The steep rocky terrain that mountain goats use to avoid predators makes them relatively difficult to harvest with traditional weapons and early records suggest that Alaska Native communities probably coexisted well with goats in the Kenai Mountains. The advent of modern firearms, however, changed the game as hunters became increasingly efficient at harvesting goats at greater distances.

Prior to 1971, mountain goat harvests in the Kenai Mountains were essentially unrestricted. Harvests during the 1950s and 1960s resulted in significant declines in many mountain goat populations. As relatively high harvests continued throughout the 1970s, Kenai goat populations declined by 25% or more. Much of the following was pulled from an excellent article by Thomas McDonough and Jeff Selinger, local biologists with the Alaska Department of Fish & Game.

In some areas, like Cecil Rhode Mountain near Cooper Landing, overharvests even resulted in localized extirpation. Reintroductions during the early 1980s, coupled with natural recolonization from nearby areas and limited local harvests, helped reestablish the population of mountain goats that we see there today.

During the early 1970s, depletion of mountain goat populations became increasingly apparent and harvest limits were reduced to one goat per year. The total number of hunters afield, however, was not limited and goat populations continued to decline under high harvest pressure, particularly in easily accessible areas.

During the 1980s, ADF&G established distinct hunt units to more evenly distribute hunting pressure and protect easily accessible populations from overharvest. Limited entry draw-permit and registration hunts were also established which reduced the number of mountain goats being harvested within specific areas.

These improved management practices during the 1980s and early 1990s helped mountain goat populations rebound throughout much of the Kenai Mountains. Minimum count data show that mountain goats began to increase during the mid-1970s, finally reaching a peak during the early 1990s.

Populations declined for unknown reasons during the late 1990s and early 2000s, but many populations appear to have stabilized since 2005. Some survey units have also shown positive trends in goat numbers, and data from minimum count surveys suggest that some populations in several areas have in-

creased in recent years. These minimum count data, which provide biologists with information on population trends within survey units, generally show an overall increase in mountain goat abundance during 2005–2014.

Increased efforts by the ADF&G to educate hunters on how to differentiate billies from nannies may also have helped reduce the number of reproductive-aged females being harvested each year. As has been seen in the Kenai Mountains and elsewhere in Alaska, harvests of reproductive-aged females can result in significant population declines and even extirpation of local populations. Because native mountain goat populations generally exhibit low reproductive rates, harvests of even just a few adult females can have substantial negative effects on population performance, which can ultimately reduce future hunting opportunities for all users.

But hunting isn't the only factor affecting mountain goat population performance. Climatic conditions, such as severe winters, persistent snow conditions, and icing events can also be important limiting factors that can affect goats in the Kenai Mountains. The role of our rapidly warming climate in mountain goat population dynamics in the Kenai Mountains is an important aspect of their ecology that warrants further investigation. As with wild sheep, diseases and parasites may also play an important role in population dynamics, but relatively little is known about how these factors affect populations.

For a more detailed history of mountain goat populations in the Kenai Mountains, I encourage you to read the original article that was published in the Proceedings of the 16th Biennial Symposium of the Northern Wild Sheep and Goat Council (http://media.nwsgc.org/proceedings/NWSGC-2008/NWSGC_2008.pdf).

Later this summer, biologists from ADF&G, Kenai Refuge, Chugach National Forest and the National Park Service are planning to conduct the first complete estimate of mountain goat populations on the Kenai Peninsula since the 1960s. Stay tuned!

Dominique Watts is a wildlife biologist at Kenai National Wildlife Refuge. Find more information about the refuge at http://kenai.fws.gov or http://www.facebook.com/kenainationalwildliferefuge.

River otters: always a pleasure to observe in the wild

by Ted Bailey

River otters are uncommon but well distributed on the Kenai Peninsula (credit: Ted Bailey).

My first experience with river otters began in the mid-1960s as an "older"—just out of the military—university student. I was approved to conduct an undergraduate research project on two young semi-tame river otters, a male and female, who my advisor had obtained from then-river-otter-expert Emil Liers of Minnesota. The semi-tame otters had never seen or eaten a fish and my study was to determine if the otters would instinctively know how to catch fish underwater or had to be taught (by their mother). I was also responsible for the daily care of the otters and thus became very familiar with otter vocalizations and behavior.

For the fish-catching behavior experiments, I observed the otters in a large tank through an underwater window. After first documenting the otter's swimming agility over several weeks I placed a green sunfish into their tank. It was the first time the otters had seen a fish. Out of great curiosity the otters first merely followed the new creature suddenly swimming in their tank. Then the male tried to catch it and after several unsuccessful attempts finally managed to outmaneuver the fish.

But once the otters caught a fish, the "fun" of the pursuit appeared to be over and they let the dead fish fall to the bottom of the tank and then losing interest swam away. But they eventually discovered that these "fast-swimming-fun-to-catch" creatures were also edible. I concluded that for these young otters catching fish was an inherited behavior that merely required practice, not a learned behavior. Since that time long ago I developed a life-long affection for these intelligent, inquisitive, vocal, and playful animals.

It is therefore always a great pleasure for me to fortuitously encounter river otters in the wild because such encounters are rare. If I am lucky, while hiking and canoeing on the Kenai National Wildlife Refuge, I will see a river otter about once every three or four years. My son, who often canoes on remote lakes in the Kenai Lowlands, sees them more often. He once had a family of otters play nearby and swim under his canoe.

Once in the 1990s, when then-refuge-pilot Bill Larned and I were flying wildlife surveys high in the Kenai Mountains above the small lakes near the head of Cottonwood Creek on the south side of Skilak Lake, we saw a lone river otter out in the middle of nowhere loping and sliding along in the snow, headed over the high snow-covered mountains toward the upper Killey River drainage. I also sometimes observed river otters on the edge of ice along small unfrozen creeks or the Kenai River. It was always reassuring to know they and other wildlife had a secure home on the Kenai Refuge.

From a biased human perspective, river otters are one of the few wild carnivores that seem to enjoy their lives. They spend time close together as a family group, chasing and wrestling each other, sliding down banks, and investigating everything that attracts their attention. I hope someday to see yet another river otter in the wild. It's about time—the last one I saw was in March 2014!

Dr. Ted Bailey was supervisory wildlife biologist at the Kenai National Wildlife Refuge before retiring in 2001. He has lived on the Kenai Peninsula for over 40 years. Find more information about the Refuge at http://kenai.fws.gov or http://www.facebook.com/kenainationalwildliferefuge.

Breaking in Marsh Lake Trail

by Travis Mabe

A view from the top of the hill overlooking Marsh Lake in the Kenai National Wildlife Refuge. Various animal tracks can be seen along the trail (Travis Mabe, USFWS).

As March becomes a distant memory, time does remain for some end-of-the-season skiing or snowshoeing before spring finally decides to roll into town. I've been told by far wiser and experienced skiing gurus that the conditions are still excellent to get out and hit the trails especially on a cold morning. If a last minute winter adventure sounds like your cup of tea, then allow me to convince you to try a new trail in the Skilak Wildlife Recreation Area (SWRA): the Marsh Lake Trail.

If you are at all familiar with the trails in the SWRA you are probably thinking, "What Marsh Lake Trail?" In all honesty, that line of thinking is completely justified since the trail and parking area won't be completed until this summer. However, don't let that stop you from getting an early start on the three miles of trail that are ready for use.

Marsh Lake Trail came into existence during the 2015 Card Street Fire when a fuel break was created that became the foundation for the trail. Not ones to miss out on a golden opportunity, the visionary minds at the Kenai National Wildlife Refuge took full advan-

tage of the lemons, a wide and rough "cat trail" they were handed, and made some very tasty lemonade in the form of a diverse and exceptional trail.

This lovely lemonade has many highlights that will surely have you itching to check them out for yourself. Marsh Lake Trail will take you on a journey through recently burned areas and mature boreal forest. This mix of forest habitat makes for abundant opportunities to bird and view wildlife, and an excellent place to observe tracks in the snow. I saw tracks of moose, spruce grouse, coyotes, snowshoe hares, red squirrels, shrews and lynx using the fuel break as their own personal highway. Of these animals, my recent trip afforded me a good look at a browsing moose.

Even if you don't happen to luck into an exceptional wildlife viewing opportunity, the views that this trail gives of the Kenai Mountains and the Tustumena Bench Lands are worth the trip themselves. Several open areas along the trail provide amazing views as well as a rewarding overlook of Marsh Lake at the trail's terminus. Just a few reasons you shouldn't forget your binoculars and a good camera.

Excited yet? Before you dive head first onto the trail, here is a brief overview of the trail as of Monday, March 27. The first mile of the trail has seen a decent amount of traffic and is packed down for snowshoes, but a little difficult on skis since it's quite slick. Fortunately, the newly fallen snow from Tuesday and onward should have remedied this situation for skiers.

After the first mile, the trail is free of human traffic with the exception of a lone and slightly insane skier, yours truly. The snow made for great skiing, even for one such as me with a meager 6 days of classic skiing experience under my belt. More proficient skiers will have an easier time, especially on some of the steeper hills. Though the steep hills are few in number, I did encounter one which I jokingly named "The Bad Hill," where I was forced to take off my skis and trek up it on foot. "The Bad Hill" will pose a worthy challenge even for veteran skiers, but the top offers an excellent view that makes it worth the effort. The snow itself varied along the trail due to sun exposure, making some areas great for gliding, while others turned my ski trip into brief bouts of "ski-shoeing."

With these conditions in mind, I highly recommend packing a pair of snowshoes just in case things get particularly dicey in skis. Another recommendation for your pack is to have plenty of water and high energy snacks which will make the 6-mile roundtrip much more manageable and enjoyable. Be sure to dress in layers and be prepared for a longer time on the trail than you expect. It took me 3 hours to ski the 3 miles going out to the hill overlooking Marsh Lake. The return trip was much easier and took half the time.

Whether you have the time or need to make time, be sure to tackle the Marsh Lake Trail before the snow disappears! Speaking of time, take your time as you go to ensure you don't miss any of the wildlife treasures this trail holds for those bold enough to give it a go! But, if you can't make it out for the snow, the trail will still be around for summer hiking and would make a great spot to have some "lemonade" or a picnic.

Happy trails, fellow adventurers!

Travis Mabe is a Student Conservation Association intern focusing on environmental education and assisting with visitor services for 9 months this year at the Kenai National Wildlife Refuge. Find more information about the Refuge at http://kenai.fws.gov or http://www.facebook.com/kenainationalwildliferefuge.

American marten on the Kenai are climate change "winners"

by John Morton

An American marten with a VHF radio collar was part of graduate research to assess if and why their distribution on the Kenai Peninsula has changed in recent years.

Last month, I skied Resurrection Trail from Hope to Cooper Landing, a fun adventure that I haven't done in several years. On both trips, I saw lots of American marten tracks in the snow along Resurrection Creek and even more on the ridges above as the trail climbs towards Devils Pass.

Marten have always been abundant in the Kenai Mountains, at least through the last century. The difference between the not-so-distant past and now is that marten were almost nonexistent on the western Kenai Lowlands when I skied through Devils Pass more than a decade ago, but are much more common nowadays.

Biologists on the Kenai National Wildlife Refuge monitor furbearer harvest by trapping, including the take of marten. From 1960 through 2000, only 19 marten total were reported trapped on the refuge. But since 2002, 93 marten have been harvested, with 18 taken just during the 2009–10 season, almost as many in that one year as in the last 4 decades of the 20th century.

What changed? This question was asked by Dr. Andy Baltensperger, a former graduate student at Colorado State University, who studied the behavior and distribution of marten on the Kenai Peninsula during 2007–08. And his answer was published just last month in the *Journal of Mammology*.

Andy initially thought that snow conditions might have changed in such a way that marten could not only survive in the Kenai Lowlands but successfully reproduce. Over most of their continental distribution, marten rely on the winter snowpack to carry them through the winter. They spend much of their time under the snow, preying upon voles and other small mammals, and resting in subnivean dens that are much warmer than ambient air temperatures. However, the sparse data we have from snow-recording stations on the peninsula strongly suggest that snow pack has certainly not increased in recent decades but may have actually decreased.

So something else was allowing marten to thrive in recent years on the Kenai Lowlands. Andy needed both historic and contemporary data on marten occurrences to model which variables affected past and future distributions. He used a "heuristic" approach in which data from multiple sources were modeled with RandomForest, a machine-learning algorithm. In this case, Andy compiled records of marten occurrences between 1906 to 2010 from museum records at the University of Alaska Fairbanks (UAF) and the University of California Berkeley, sealing records from the Alaska Department of Fish & Game, Kenai Refuge furbearer records, interviews with local trappers, and a 1989 study of marten in the Surprise Creek watershed. Additionally, Andy identified marten tracks in still photos extracted from a 2006 aerial digital videography

survey, and from his own live-trapping efforts in lowland and mountain habitats on the Kenai Refuge in 2007–08.

His analysis revealed an ongoing westward expansion of American marten on the Kenai Peninsula since circa 1988, but principally during the past 15 years, which coincides well with Kenai Refuge harvest records. His models suggested that several factors, including soil and landcover, influenced marten distributions. But warming temperatures, particularly at night during the winter, is the likely explanation for why marten were able to colonize the western peninsula despite any decreases in snow cover. Average January temperatures at the Kenai Airport in January have increased 7 degrees F over the past 50 years!

Marten in the Kenai Lowlands were also able to take advantage of red squirrel middens, the pile of spruce cone bracts left behind after their seeds have been eaten. Temperature recorders indicated that rest sites more than a foot deep in middens adequately insulated marten even in the absence of snow cover.

Coincidentally, other research published in 2008 showed that the average skull length of marten in Alaska, based on 400 museum specimens at UAF, has increased by 0.03 percent over the past 50 years. This increase in body size is attributed to shorter, warmer winters that have allowed for accelerated plant growth and a resultant increase in the size and availability of voles and shrews. What a tangled ecological web climate change can weave!

In a warming climate, species are expected to move northward in latitude and upward in elevation. This is indeed the case with marten on the Kenai Peninsula. They appear to have successfully spread westward into the Kenai Lowlands from long-standing suitable habitat in the Kenai Mountains. Some ecologists would label American marten a "winner" in the context of how climate change impacts species.

However, the Kenai is separated from mainland Alaska by a mostly ice-covered, 10-mile-wide isthmus between Portage and Whittier that constrains plants and animals from migrating onto the peninsula. Species moving up the Alaska Coast Range that can't fly may not make it to the Kenai Peninsula even if our climate changes enough to sustain them. In that scenario, it's not so much that those species are "losers", but perhaps we lose out by not having a biologically more diverse landscape in which to live.

Dr. John Morton is the supervisory biologist at Kenai National Wildlife Refuge. Find more information about the Refuge at http://www.fws.gov/refuge/kenai/ or http://www.facebook.com/kenainationalwildliferefuge.

Spring into Earth Day

by Leah Eskelin

Community groups, like this Girl Scout Troop cleaning up Slikok Creek, help get the Kenai Peninsula ready for summer (credit: Leah Eskelin/USFWS).

It's spring! I celebrate this fact in the sun warming my back, the drip, drip, drip of water melting off the roof, and the patchwork quilt of snow in the forest outside my window where, soon, little sprigs of green will push up through the accumulated birch seeds and brown leaves. I celebrate this change of seasons before, in its fleeting way, spring becomes summer and everything speeds up.

I take note of the way the frost looks on my car door in the morning since it will be gone by midday. I count the new birds each day who come to visit the feeder because soon their bright songs will fade as they start to nest. The feeder will come down this week, too, and the last of the seed will get raked up, so it doesn't entice neighborhood visits from a bear family. I look for this family's tracks as I stroll along a puddly trail, and enjoy seeing a caribou grazing in a meadow. I take note of spring as I gear up for summer.

I also take note of something else, and it makes me stop in my tracks: the glint of aluminum in the roadside ditch, a wind-rustled plastic bag fluttering from the willow branch, the soggy cardboard debris once

hidden under months of accumulated snow. It all has been revealed. It's time to take action! I carry a small trash bag for just this opportunity, to leave this place cleaner than it was when I arrived. I take a moment to pick up the trailhead. I drop the aluminum can in my truck bed to recycle, and the trash bag beside it. It's not much, but my effort is noticeable.

As we approach April 22nd, Earth Day, the little things we can do to help the Kenai Peninsula get ready for summer can make a big impact. We can all take steps to help protect the environment. Called "Acts of Green," the collective effect of these small actions are how salmon streams stay clear of debris, how roadsides get filled up with lupines and fireweed instead of discarded trash, how recyclables stay out of the landfill and how 2 million acres of public land we call the Kenai National Wildlife Refuge stays wild and clean.

A caribou snacks on a sunny spring day (photo credit: Leah Eskelin/USFWS).

What are some "Acts of Green" that really make a difference? First, an easy one for all ages: **Pick up Litter**. What gets thrown out now eventually makes its way to the ocean where the impacts of one little plastic bag, even when it degrades into very small pieces, will be felt for 400 to 1,000 years, being consumed by or ensnaring marine animals for generations.

Second, **Plant Native**. When we add native plants to our gardens we support local pollinators like butterflies which in turn help keep habitats healthy and diverse.

Third, **Clean Up Pet Waste**. The melting snow reveals a mine field of scat in many yards and on roadsides this time of year. Spending the time now to pick up this waste helps protect our waterways from runoff pollution that can harm fish and other wildlife and make the water unsafe for drinking.

Another "Act of Green" that has a potentially monumental impact on wildlife is to **Avoid Cat Predation**. Remember those birds I have been counting at the feeder? Cats are responsible for killing over a billion wild birds annually. Keeping cats indoors means songbirds can successfully nest, migrate, and remain a part of the Kenai ecosystem. "Acts of Green" can become the norm, done every day without conscious effort, it just takes practice. That's where Earth Day at the Kenai Refuge comes in.

Spring is an opportunity for communities everywhere to stretch their winter-weary legs, get outside and explore. I hope you and your family will join the Earth Day Celebration at the Kenai National Wildlife Refuge Visitor Center in Soldotna. On Saturday, April 22, 2017 from 2:00 until 4:00 pm, rangers and refuge volunteers will host a Discovery Room full of earth-friendly activities including recycled wire jewelry, native seed planting, a recycling relay race (can you beat the ranger?) and reusable tote bag decorating (while supplies last).

Drop in for some hands-on fun suitable for all ages then hit the Keen-Eye Trail for a short walk and soak up springtime. Children can even earn their Junior Ranger badge and start the summer off with their own "Act of Green." Call the Visitor Center at 907-260-2820 for details.

Leah Eskelin is a Visitor Services Park Ranger at the Kenai National Wildlife Refuge. Find more information about the Refuge at http://kenai.fws.gov or http://www.facebook.com/kenainationalwildliferefuge.

Surprising trees grow on the Kenai Peninsula

by John Morton

A maple planted at Soldotna Creek Park (credit: John Morton).

Last June, I was enjoying the sun while listening to music at the Kenai River Festival. If I hadn't been sitting (and it had nothing to do with the beer in my hand), I might have fallen over when I noticed a tree planted at Soldotna Creek Park. It was a maple! The nearest naturally occurring relative, the Rocky Mountain maple, grows in Southeast Alaska.

The timing was auspicious. I'd been thinking about how our native trees are responding to a warming climate. Mother Nature dealt us a small hand to work with: three spruce species (white, black, Sitka) and one hybrid (Lutz), one aspen, two birches (white, Kenai), two hemlocks (mountain, western) two cottonwood subspecies (black, balsam), two willows (Pacific, Scouler's), one mountain ash and at least one serviceberry. I had been discussing with Mitch Michaud, a local forester, the idea that soil temperatures have increased on the central peninsula to the point that cottonwood seemed favored in disturbed soils whereas birch was looking drought stressed.

So this unexpected maple got me thinking about what else might be growing here on the Kenai. In response to my query, I received great information from inventories of Soldotna by the State Division of Forestry, of Seward by Carol Griswold, of the Homer Demonstration Forest by Dave Brann, and from helpful members of the Homer and Central Peninsula Garden Clubs.

As background, it's important to recognize that the Kenai Peninsula has varied microclimates. The U.S. Department of Agriculture's Plant Hardiness Zones range from 4a (-30 to -25 degrees) in Soldotna to 5a in Ninilchik, Hope and Clam Gulch to 6b (-5 to 0 degrees) in Seward and Seldovia. And it's changing quickly. The Scenarios Network for Alaska and Arctic Planning at the University of Alaska Fairbanks forecasts that the growing season on the central peninsula will increase almost a month by 2100!

Here's what I learned from my respondents. As expected, lots of fruit trees—Manchurian apricot, Ussurian pear, nonnative serviceberry and multiple varieties of apples, crabapples and cherries.

Almost unbelievably to me, red and burr oaks, green ash, Siberian elm, five species of maple and two of basswood, Russian olive, Norway poplar, European mountain ash, two nonnative birches and eleven species of willow grow here. Amur maples, native to northern Asia seem to do particularly well. In Minnesota, they do so well they're considered invasive.

Among softwoods, we have white and western red cedars, nine firs, eastern hemlock, juniper, four larches, eleven pines and five nonnative spruces. We have balsam fir, Douglas fir, grand fir, Korean fir, Sakhalin fir, Shasta red fir, silver fir, subalpine fir and white fir. The pines include Austrian, bristlecone, eastern and western white, lodgepole, limber, Manchurian, mugo, Ponderosa, Scotch and Siberian.

As many locals know, lodgepole pine thrives here, although the nearest naturally occurring populations are in the Yukon Territory. Some of the oldest lodgepoles on the Kenai may be the ones planted by a Straw-

berry Road landowner in a fire break six years after the 1969 Swanson River Fire—almost a half century ago!

An unusual tree that folks in Homer are planting is the Dawn Redwood or Metasequoia. This deciduous softwood (similar to larch) once grew as far north as Ellesmere Island but was previously only known from 30-million-year-old fossils. In 1943, however, a remnant stand of 5,000 living Metasequoia was found in western China, and their seeds have since been planted in arboretums and botanical gardens around the world including part of their prehistoric range here on the Kenai Peninsula.

If you're gearing up to plant trees this spring, I do have some guidance. Other things being equal, plant native species. But if you insist on grabbing trees from elsewhere, I suggest only planting trees indigenous to North America, not Asia or Europe or any other continent. So plant Alaskan larch (also known as tamarack) that is native to the Yukon River basin, rather than Siberian larch, even though the latter tends to grow better on the Kenai Peninsula than the former. The reasoning behind this is two-fold. In our warming climate, in which species are trying to migrate northward in latitude, you're really only accelerating a process that would otherwise take centuries. But by keeping your choices to North American species, we're not creating a circumboreal community with low genetic diversity, and so we can help maintain global resilience at a continental scale.

Also, give some serious thought to whether or not a species might become invasive and injurious when transplanted to the Kenai Peninsula. I've already mentioned that the Amur maple might be a poor choice—a single tree can produce more than 5,000 two-winged seeds or samara that are widely dispersed by wind. The European bird cherry or Mayday tree (*Prunus padus*) is a poor choice because it can kill moose that browse on its cyanide-laced foliage as it has in Anchorage. But I'd argue that both species are from the Old World and so you shouldn't be planting them here anyways.

The Alaska Division of Forestry maintains a helpful online database of trees and other plants that can be used for landscaping in Alaska. Go to this link (http://alaskaplants.org/) and you can search by region to find more than 300 species that grow in southcentral Alaska.

Dr. John Morton is the supervisory biologist at Kenai National Wildlife Refuge. Find more information about the Refuge at http://www.fws.gov/refuge/kenai/ or http://www.facebook.com/kenainationalwildliferefuge.

A Dawn Redwood grows in Homer. Until it was rediscovered in China in 1943, this species was only known from fossil records (credit: Paula Riley).

Using drones to monitor nesting Aleutian Terns

by Mark Laker

Mark Laker launches a drone on an automated aerial photography mission to survey Aleutian Terns on the Kenai National Wildlife Refuge.

On the Kenai National Wildlife Refuge near Headquarters Lake is a small colony of Aleutian Terns that nest alongside Arctic Terns. Aleutian Terns breed in small colonies along the Alaska coast and in the Russian Far East. Unlike the Arctic Tern and other more abundant seabirds, very little is known about the Aleutian Tern.

Heather Renner from Alaska Maritime National Wildlife Refuge coauthored a paper in 2015 on the breeding distribution and population trends of Aleutian Terns. In brief, by analyzing surveys conducted since 1960, the Alaska population of Aleutian Terns has declined by an alarming 93 percent. No single factor was identified for this decline. Due to the limited knowledge of this species, there was a general call for increased surveys of known colonies.

With this in mind, my colleagues Dawn Magness and Todd Eskelin approached me about the feasibility of conducting surveys of our Aleutian Tern colony using drones. Over the past several years Kenai Refuge staff have been active in developing low cost aerial photography systems based from helicopter and fixed wing platforms. We have been very successful in creating large landscape-scale photo mosaics and surface elevation models that cost only pennies per acre.

However, for some projects, the use of manned aircraft would be costly, too low in resolution, negatively impact wildlife, or expose personnel to unnecessary risk. One solution we started to investigate two years ago was small Unmanned Aerial Systems (sUAS), also known as drones. At that time, Department of Interior policy on UAS was still being developed, so we had to put those plans on hold. But, long story short, after several licenses, certifications, and training classes these past few years, I was finally given the authority to operate an sUAS.

Typically bird colonies are surveyed by foot, but this method has some dire consequences for Aleutian Terns. In the case of Arctic Terns and some other marine birds, if you approach the colony, they will start dive bombing you to protect their young. If threatened, Aleutian Terns will not defend the nest, but may abandon it.

The prospect of remotely photographing birds in the colony was tantalizing, but many challenges exist. The drone we have is a small quadcopter (3DR Solo), with a payload capacity of about 1 pound. At an altitude of 100 feet, the camera records at a resolution of less than 1/3 inch. To fly the drone in the precise grid required, an application called Tower is used as an autopilot. Using modern photogrammetry software, I can stitch or mosaic multiple individual images to create a single image called an orthomosaic.

One question we wanted to answer prior to the arrival of the terns is how high can we fly and still be able to discern between Arctic and Aleutian Terns. Using a variety of decoys, we took photos at different altitudes, camera settings, and lighting conditions. We are cautiously optimistic that an altitude of 75–100 hundred feet will allow us to discriminate Aleutian Terns.

The next and probably most important question is whether or not the drone will disturb the nesting terns. Our plan is to fly a series of desensitization flights at altitudes starting at 300 feet and work our way closer to the ground. We will have an observer hidden in a blind to watch the birds' response. Birds remain on the nest when they start incubating, so we should be able to track nesting success. To further test our ability to detect nesting birds, we plan to equip the drone with a thermal camera, which should help us find birds hidden by grass.

As an FAA-licensed UAS operator for the U.S. Fish and Wildlife Service, it's easier for me to remember the small handful of can-do's rather than the extensive list of don't-do's. One of the greatest hazards of flying a UAS is the chance of a midair collision with another aircraft. It is the responsibility of the UAS operator not to interfere with manned aircraft. As a precaution, due to our proximity to the Soldotna Airport, I file a notice with the local Flight Services before any operation to alert pilots of our activities. Additional observers also assist me to keep an eye out for other aircraft. The FAA has several online resources and a phone app (B4UFLY) to assist drone operators to fly their aircraft safely and responsibly.

As a cautionary note, the recreational use of UAS or drone is prohibited on the Kenai Refuge (and the majority of Alaska public lands).

Mark Laker is an Ecologist with the Kenai National Wildlife Refuge. Find more information about the Refuge at http://www.fws.gov/refuge/kenai/ or http://www.facebook.com/kenainationalwildliferefuge.

Celebrating wildlife mothers

by John Morton

Moose cows are notorious for being great mothers to their young (credit: J. Morton).

This Sunday is Mother's Day, a national holiday that President Woodrow Wilson designated in 1914 as World War I was unfolding. But, like most things in life, there's a back story to that simple proclamation. Anna Jarvis held a memorial in 1908 in Grafton, West Virginia, to honor her mother's time caring for wounded soldiers on both sides of the American Civil War. It took six years of Anna's persistence in both petitioning Congress and eliciting public support before this special day to honor all mothers came to be.

There are also many stories of great maternal heroics among wildlife. Kangaroo mothers carrying their joey (baby) in their marsupial pouch prompted the coining of "Kangaroo Mother Care", a method in which preterm human babies are held and carried skin-to-skin by their mothers. Google "cuddly bear daycare" and see how many daycares bear (pun intended) that name to honor the maternal care shown by bear sows to their cubs.

Here's a true story. Two or three years ago, I was biking up Devils Pass Trail from the Seward Highway in late May or early June with a friend. Over our own grunting and wheezing for oxygen, it slowly dawned on me that I was hearing very strange raven-

like noises. Once we stopped, I realized the "ravens" were bears bawlin' at the top of their lungs. Across the narrow and steep valley, two small cubs were jumping up and down on their hind legs, "cheering" with their front paws waving around with arms held high. It took more than a few seconds to figure out they were trying to see over last season's brown grass, but mom had apparently told them to stay put.

Then we noticed the reason for their excitement—a very agitated female caribou circling just out of reach of mamma bear, a strange tactic to take or so it seemed initially. It all made sense when the sow gave up the chase, returned to an alder clump, and came out with a very small and now dead caribou calf in her jaws.

About then, mamma bear became aware of us a quarter of a mile away line-of-sight but, fortunately, a much greater distance across the valley floor. She chose to angle up the ridge with her two cubs in tow and their dinner, while the caribou slowly pranced away in the opposite direction. Two spectacular mothers doing what mothers have always done—feeding and defending their young. Only in this case, the sow won and the cow lost.

Mother Nature isn't always kind, but she does offer other great examples of wildlife moms that can be seen here on the Kenai Peninsula. Moose cows are notoriously protective moms who will fall on their sword for their offspring. It's about this time of year that pregnant cows begin to calve, which is also a time when they can get very aggressive. And they need to be as this is when brown and black bears make their way to moose calving grounds.

If you have a neighborhood cow that you've peacefully passed all winter long, don't assume that will be the case over the next 2 or 3 weeks. If the ears go back, you should probably just start running. On the other hand, this is also when you'll see pregnant cows driving away last year's offspring. While it doesn't look very maternal, it's a necessary behavior for mom to make room for the calf on the way.

Beluga whale moms, like other mammals, nurse their calves (for up to two years!) from nipples concealed in abdominal mammary slits. Calves can be born anytime between now and the end of summer, and mothers with calves will often form pods separate from males. Belugas often feed at the mouth of the Kenai River this time of the year, chasing hooligan or early-run Chinook salmon. Consider taking the time to watch for them from the bluffs in Old Town Kenai.

Female Trumpeter swans, called "pens", are also incredible moms. Cygnets require so much time (11 to 15 weeks) to become flight-capable that they occasionally get trapped by ice before they can fly south for the fall. Consequently, Trumpeter swan pairs typically arrive on their breeding grounds when snow is still on the ground to ensure that nest building starts as soon as ice goes out. Pens and their mates ("cobs") migrate south in the fall with their brood to their wintering grounds. There, they hang together as a family group, sometimes until they arrive back on their breeding grounds the following spring.

So, as you celebrate your own mother this Sunday, take the time to reflect that motherhood and good parenting aren't just human traits.

Dr. John Morton is the supervisory biologist at Kenai National Wildlife Refuge. Find more information about the Refuge at http://www.fws.gov/refuge/kenai/ or http://www.facebook.com/kenainationalwildliferefuge.

A very cute Beluga whale calf may nurse from its mom for two years! (credit: Caters News)

Hiking in the Kenai National Wildlife Refuge

by Amber Kraxberger-Linson

Dr. Taz Tally (with his dog Zip), author of 50 Hikes In Alaska's Kenai Peninsula*, will be at the Kenai Refuge Visitor Center on May 27 (Photo credit: Taz Tally).*

What type of trail am I hiking today? Do I need my hiking poles? Skilak Lookout Trail has that steep climb at the end so, yep, I should probably bring them. Regardless of the trail, I'm going to need some bug spray. These are the things that run through my mind when I'm getting ready for a day on the trail. Whether I'm hiking with friends and family or I'm meeting hikers for a Discovery Hike in the Skilak Wildlife Recreation Area (SWRA) I try to plan out my day and be prepared. Summer is around the corner and now is the time to think about which trails you might want to visit.

The Kenai National Wildlife Refuge offers a variety of hiking opportunities that are easily accessible just minutes from the Kenai-Soldotna area. There are ten trails (Hideout, Upper Kenai River, Lower Kenai River, Burney's, Hidden Creek, Skilak Lookout, Bear Mountain, Vista, Seven Lakes and Marsh Lake) in the SWRA and three (Skyline, Fuller Lakes and Egumen) that are located off the Sterling Highway. These trails range from easy to very strenuous while offering a variety of landscapes and breathtaking views.

If you would like the opportunity to get familiar with Refuge trails, Discovery Hikes led by a ranger in the SWRA will be offered every Friday at 1PM from June 16–August 18. Scheduled trail hikes include Hidden Creek (June 16), Hideout (June 23), Burney's (June 30, July 28), Vista (July 7, August 4), Lower Kenai River (July 14), Seven Lakes (July 21), and Upper Kenai River (August 11). The schedule may be subject to change due to trail conditions. Call the Kenai National Wildlife Refuge Visitor Center at 907-260-2820 to confirm the designated trail of the week.

If you are looking for an excellent and beautifully photographed guide book on hikes all around the Kenai Peninsula then come to the Kenai Refuge Visitor Center on May 27 at 2:00 PM. Taz Tally will give a presentation and sign his book of *50 Hikes in Alaska's Kenai Peninsula.* After the presentation, join Taz for a three-quarter mile hike on the Keen Eye Nature Trail. In addition to being a photographer and an avid four-season outdoor athlete, Dr. Tally is a geologist. The Homer resident has authored numerous books and online training courses on digital photography.

On June 4th at 2:00 PM celebrate National Trails Day with a 1 ½ hour ranger-led hike on Centennial Trail starting from the Visitor Center. Regular Centennial Fitness Walks will occur each Sunday at 2PM led by a park ranger. These moderate-paced guided hikes on the 3-mile Centennial Trail are tailored to adults and designed to move faster than other hikes offered on Headquarters Trails. Please do not bring pets.

When you do head out for the trails, keep these helpful hiking tips in mind. Downhill hikers should yield to hikers who are going uphill. The hikers going uphill are working hard so why not step aside and take a few moments to enjoy the view. Speaking of taking a break, if you decide a little rest is in order move off

the trail to allow others to walk by unobstructed.

A very important component of hiking is practicing good Leave-No-Trace principles including packing out all your trash. Even biodegradable items like banana and orange peels should be carried out. These items take a while to decompose and no one wants to come to the trail's end and see the remains of your lunch sitting there. A banana peel takes 3—4 weeks to decompose while an orange peel can take up to 6 months!

If nature calls while you're hiking, move at least 200 feet off of the trail, away from campsites and water sources. Do not leave toilet tissue above ground. Pack out used tissue or bury your waste and tissue in a "cathole" 6—8 inches deep and 4 inches across. Toilet tissue breaks down faster when exposed to moisture and organic microorganisms. Besides the negative health effects and possible spread of disease associated with human waste, no one likes seeing wads of used toilet paper in their favorite hiking or camping area.

There are multiple benefits to getting out and connecting with Nature through hiking that have been reported in numerous studies: lowered stress levels, higher bone density, and increased fitness. I can personally attest to feeling an immense sense of accomplishment and well-being after completing a hike. It's addicting!

I love hiking the trails of the Kenai National Wildlife Refuge because there is always something new to see. Landscape that has been touched by fire comes back to life and wildlife returns to the area. New trees spring up and once mighty trees are taken down by high winds or snowpack. The landscape is always changing and if we take the time to look and visit often, we might just see it.

Amber Kraxberger-Linson is a Visitor Services Park Ranger for the Kenai National Wildlife Refuge and a life-long Soldotna resident. Find more information about the Refuge at http://www.fws.gov/refuge/kenai/ or http://www.facebook.com/kenainationalwildliferefuge.

Butterworts: carnivorous and easily overlooked beauties

by Matt Bowser

Hairy butterwort in blossom at Headquarters Lake, June 10, 2015 (credit: Matt Bowser/USFWS).

At first glance the insect-eating hairy butterwort, one of the smallest flowering plants on the Refuge at about two inches tall in full flower and sporting only 2–4 tiny leaves, seems incomparable to the famous, fictitious, voracious Audrey II from the musical, *Little Shop of Horrors*. What makes the equally hungry but far smaller butterworts far more interesting to me is that they are really real. With effort you can witness these and other carnivorous plants eating animals in a wetland near you.

In contrast to much of the Lower 48 where draining of wetlands and over-collecting has led to scarcity of carnivorous plants, they are still quite common in our area. The hairy butterwort is one of seven carnivorous plants known from the Kenai National Wildlife Refuge (two sundews, three bladderworts, and two butterworts), making our area comparatively rich in carnivorous plant diversity. You can see five of these species without walking very far into the wetland around Headquarters Lake in Soldotna.

It is no coincidence that all of our carnivorous plants reside almost exclusively in wet, nitrogen-poor habitats. Any experienced gardener can tell you that most plants require plenty of nitrogen in the soil to be productive. In wetlands where nitrogen can be extremely scarce, carnivorous plants attract, capture, and digest nitrogen-rich insects to supplement their otherwise meager diets.

Butterworts employ a unique flypaper-like mechanism to capture and digest their prey. Two kinds of sticky glands coat the upper surface of the prostrate, spreading leaves. Taller stalked glands trap small insects in goo. Responding to contact with nitrogen-rich animal proteins, unstalked glands on the leaf surface then release digestive enzymes. Slowly, over a matter of hours, the nearest leaf edge rolls in toward the dead animal, aiding in digestion. Eventually the leaf flattens again, ready for the next victim.

Larger insects easily escape from the microscopic glands, so butterworts' animal diet comprises smaller springtails, midges, and aphids. They can also obtain nutrition from pollen and other protein-rich plant parts that end up stuck on their leaves, making butterworts one of the only herbivorous plants.

The sticky glands can only be used once, and hard-to-digest insect skeletons persist on the leaf surface, so the leaves lose effectiveness as traps over the course of the summer. For this reason these plants capture progressively fewer insects as the growing season progresses.

Interestingly, butterworts interact with insects not only as potential food items. Flying insects pollinate the attractive, showy flowers.

I was surprised to learn that butterworts have a long history of use by humans, mainly in dairy products. Historical accounts describe a process where milk was inoculated with mucus from butterwort leaves, leading to a culture of specialized *Lactococcus* bacteria that made a thick, yogurt-like product. *Tettemelk*, one of many names for this food, has been prepared in Scandinavia for at least 150 years and is

produced commercially today. The process no longer involves butterworts, but recent DNA evidence confirmed that the bacteria used in *tettemelk* production today are identical to some of the many kinds of bacteria residing on leaves of butterwort.

Partially digested carcass of a springtail caught by a hairy butterwort at Headquarters Lake, May 22, 2017. Note the glistening glands discernable in this image (credit: Matt Bowser/USFWS).

Proteases (enzymes that break down proteins) from butterworts were also used to curdle milk and tenderize meats up through the early twentieth century, but since then the practice has ended as other sources of proteaze have replaced butterworts.

I encourage you to don your rubber boots and explore your neighborhood wetland to see butterworts and our other carnivorous plants for yourself. Hairy butterworts can be spotted most easily in early to late June when their pretty purple flowers make them more conspicuous in lowland fens. The common butterwort, a larger and showier relative of the hairy butterwort, can be found in wet places in the Kenai Mountains.

Matt Bowser serves as Entomologist at the Kenai National Wildlife Refuge. You can find more information about the Refuge at http://www.fws.gov/refuge/kenai/ or http://www.facebook.com/kenainationalwildliferefuge.

Pteropods: beer nuts of the ocean

by Brenda Trefon

Acidifying oceans are killing pteropods, a favorite food of Alaska salmon.

Remember Beer Nuts®? Those sweet and salty peanuts with a crunchy outer shell used to be a staple of football parties and baseball games. Plus, who can forget that great name? Just having a bag of Beer Nuts on a road trip or at the office could bring you instant friends.

I first discovered them on a summer vacation at my cousin's cabin, as us younger kids dared each other to try those small, flavorful morsels. Beer Nuts may be the perfect snack food: tasty, crunchy, and full of protein. The only problem is that they are getting harder to find. They are no longer within easy reach at the local gas station counter or grocery store. Very few stores carry them and last time I tried to buy some, I had to walk really far, searching the aisles for that trademark red and white label of happiness. That's when I realized my favorite high-protein snack was disappearing.

The same thing is happening to our wild Alaska salmon out in the ocean. One of their favorite foods, the pteropod, is disappearing. They used to be an abundant food source, a tiny little snail eaten as a tasty treat. Pteropods are small, salty, and full of protein with a crunchy outer shell…sound familiar? Salmon eat a lot of them, making up about 60% of a pink salmon's diet in the ocean.

Like Beer Nuts, pteropods are getting scarcer. As they disappear, our salmon have to search harder for other foods, some of which have less protein so our salmon have trouble reaching their full growth potential. Taking pteropods away from our salmon is like replacing my Beer Nuts with fat-free unsalted pretzels. It's just not the same.

Studies show that pteropods are having trouble forming their shells due to changes in our atmosphere. Since the industrial revolution, humans have extracted carbon from deep in the earth in the form of coal and fossil fuels. As these fuels are burned for energy to power our cars, factories, airplanes, and power plants, they release carbon dioxide into the air. About 30% of that carbon returns to our oceans where carbon dioxide dissolves in the sea water, releasing hydrogen ions which then form carbonic acid.

Today our oceans are 30% more acidic than they were a hundred years ago. This is called ocean acidification—the sister companion of climate change. Although some people don't accept that the climate is changing, ocean acidification is a very real and dangerous problem. There are many ways acidification affects us, especially Alaskans, even if you do not live near the ocean. The increasing acidification makes it difficult for some shellfish and corals to complete their shells. Some species may continue to slowly form their shell, but will ultimately not survive to become adults because they've used up all their energy.

Why should you care? Pteropods are the bottom link in the ocean's food chain that includes our salmon. Less food for salmon means less salmon for us. Loss of pteropods affects salmon runs, commercial fisheries, the Alaska seafood industry, sport fishing, tourism and restaurants.

For many Alaskans, the loss of salmon is also the loss of our salmon culture. Salmon is part of our economy and our family life. The quest for salmon brings us together on beaches, in boats, at fish camps, while tending smoke houses, and at the dinner table. Wild Alaskan salmon are part of our local identity. It's not just about us either–across the globe, one in seven persons gets most of their protein from fish and seafood. The ocean food chain affects all of us from our own

food abundance to our local jobs and our state's economy.

There is good news, however. We can take steps to reduce our carbon emissions by reducing energy and using less fossil fuel. The amount of carbon dioxide produced by each person is called our "carbon footprint." There are websites with carbon footprint calculators that show the difference made by each person as we choose to walk or ride a bike or drive our truck or carpool with friends to save energy (and pteropods!). Making choices to reduce the energy we use, reusing items instead of purchasing new ones to cut down on packaging and consumer waste, and recycling when possible are all ways to minimize our carbon footprint.

Remember, the pteropods are the Beer Nuts of the ocean—they are a crunchy protein food source that is disappearing and difficult to replace. Choices we make every day can slow the process of ocean acidification so the pteropods can feed our salmon and our salmon can grow healthy and return to Alaska's rivers and people.

Brenda Trefon is the Environmental Program Coordinator for the Kenaitze Indian Tribe. Find more information about the Kenai National Wildlife Refuge at http://www.fws.gov/refuge/kenai/ or http://www.facebook.com/kenainationalwildliferefuge.

Faces of climate inequality

by Tracy Melvin

A Waitabu village house damaged by Cyclone Winston, a Category 5 storm that directly hit Fiji in 2016.

An 11-hour flight from Los Angeles, 1 hour flight from Nadi, and a 2-hour 4WD trek along the rugged, sun-drenched coast of Taveuni Island will get you to the village of Waitabu. A bumbling grouping of 50 people living in 15 huts, Waitabu faces an outstretched morning-sun Pacific Ocean. This is a place of relentless, unabashed, breathtaking beauty.

The weary traveler is overtaken by the sight of the surrounding countryside—a tiny green basket of life dotted with 90-foot-tall coconut palms and strangler figs bigger than city buses. You pass village men, machete in hand, on their way to tend wildish fields of taro and cassava. You pass beneath centurion mango trees, giant fruit bats roosting in their canopies. Sheer 200-foot living walls of forest greenery surround the village, where you sleep in the embrace of an extinct volcano. You are greeted by a sea of elated children, treated to feasts, given the only beds in the household, and you are made an actual villager in a cultural ritual dating back hundreds of years. Now, being a villager, you could come back and build a house.

If paradise was ever a place, it lived in the Fijian Islands. It is still there. If you are adventurous enough to escape the Americanized 5-star resorts on mangrove-bulldozed man-made islands, complete with Mexican restaurants, you can find it. If you are really adventurous, the kind of person with an open mind and an open heart, you might realize that it isn't the view that manifests paradise but, rather, the people.

In the middle of the village sits a once happy, seafoam green house with no windows, no roof, and most of the walls torn away. Pictures of family remain, left and faded by sun and rain. A few pieces of furniture are randomly strewn about but it is otherwise abandoned. Chunks of corrugated steel hide on the reef and in the rainforest. Our last clue is a sudden rain event sending village children hurtling into their homes, terrified.

Waitabu boy hides behind his mother and aunt while the village sings Isa Lei, their traditional Fijian farewell song.

Herein lies the unspoken but obvious remnants of Cyclone Winston, the strongest storm to make landfall in Fiji and the South Pacific Basin. It happened in this village three months before I visited with undergraduate students studying abroad from Michigan State University.

The storm originally passed south of Fiji only to double back two days later. A Category 5 storm, Winston reached sustained winds of 145 mph on February 20, 2016. In all of Fiji, 40,000 homes were damaged or destroyed and 350,000 people were significantly impacted, amounting to $1.4 billion in damages and 44 deaths.

You might chalk this up as a tragedy, a freak incident or even to poor planning, and move on with your day. Fiji is 5,600 miles away from Soldotna and there's nothing you can do about it. You aren't connected to this. But, in a way, you are.

Even if we make no connections between a warming planet and cyclone activity, climate change has exacerbated vulnerabilities of island nations in other ways. Waitabu is especially vulnerable to storm surges from sea level rise and its subsequent coastal erosion and saltwater inundation. More than 800 Fijian communities have already been impacted, 3 villages have been relocated, and 45 villages need to be relocated in the next decade.

Developed nations like the U.S. produce an overwhelmingly larger proportion of global carbon emissions than developing countries like Fiji, yet these poorer nations disproportionately feel the ramifications. In 2013, the U.S. ranked 13th in the world with 4.4 metric tons of carbon emitted per person while Fiji ranked 131st with 0.5 metric tons per person. These statistics don't reflect what I see in Waitabu, where villagers have no vehicle, washing machine, nor electricity besides that from solar panels, and whose carbon emissions come from cooking over a fire. The people of Waitabu, in this little droplet of paradise, are faces of climate inequality.

It's a sobering notion that the poorest of people will be the hardest hit by a warming climate. It seems reasonable that folks living furthest from a carbon-dependent lifestyle would experience the least effects, but it's quite the opposite. Climate knows no boundaries.

Alaska has its own cases of climate inequality in the tiny village of Shishmaref. Inhabited for 400 years, it was recently evacuated due to thawing permafrost, stronger storm surges and shoreline erosion. In the past 60 years Alaska has warmed by 1.7 degrees, twice that of the Lower 48. Like the villagers in Waitabu and Shishmaref, here on the Kenai Peninsula we will see the effects of a changing climate earlier and more strongly than our friends and family down south.

Unless we take a meaningful step beyond the confines of comfort and stability in daily life can we truly see the effects of it on other people and other places—and do something about it. That far-off idea of an

unspoiled, untouched paradise is fading away. It is touched. It is spoiled—by an unavoidably connected atmosphere.

When I read the headlines about Cyclone Winston, it felt as if it happened in in my hometown. I could picture my friends—real people with lives like mine, suffering. Don't allow yourself to normalize environmental catastrophe or human indifference. Meet and love people different than you, go forth and flaunt your humanity. If folks become as globalized as the atmosphere we are disrupting, we will emphatically stand up, evoke change and demand it from others.

Tracy Melvin, a Michigan State University graduate student, is researching climate adaptation on the Kenai National Wildlife Refuge. Find more information about Kenai National Wildlife Refuge at http://www.fws.gov/refuge/kenai/ or http://www.facebook.com/kenainationalwildliferefuge.

Alaska's smallest sea monster

by Cade Kellam

The intertidal psuedoscorpion, Halobisium occidentale*, is the second species of pseudoscorpion to be documented on the Kenai National Wildlife Refuge.*

Lurking in some of Alaska's woods, swamps, and rocky places is the tiniest monster one could conjure into existence. With oversized pedipalps (pincers) protruding far from the cephalothorax (head and chest), its waxy body is coated in a fine layer of bristles, giving our creature an enhanced tactile sense for seizing unsuspecting prey. Silk glands produce cocoons in which these beasts mature and brood.

This micro-monster is a psuedoscorpion, an order of arachnids. They are most easily recognized by their large pedipalps, which resemble those of a scorpion, and their plump, pear-shaped body and eight legs.

Pseudoscorpions are similar to true scorpions, but they don't have long tails that end in a stinger. These tiny predators have no ability to bite, sting or pinch humans. Also unlike scorpions, some pseudoscorpions have been known to hitch rides on flying insects, a behavior known as phoresy. Phoresy is when an animal latches onto another animal only for the ride.

A perceptive eye is necessary to spot the elusive pseudoscorpion. They range from two to eight millimeters—about half the size of a Kenai Peninsula

mosquito! Our very small neighbors are rarely seen, spending most of their lives hidden in dark places.

Male pseudoscorpions possess the skills to woo females. When pseudoscorpions prepare to take a mate they will lock onto each other's pedipalps and the intense mating dance begins! The male parades the female around until he deposits a stalked sperm packet onto the ground. He then guides her over it, where she takes it up. Truly quite the rendition of the two-step.

Three thousand species of pseudoscorpions exist globally, 300 of which can be found in the U.S. and Canada. Seven pseudoscorpion species are native to Alaska, but few people have laid eyes on these monsters due to their small size and secretive habits.

Prior to June 8, 2017, the Kenai National Wildlife Refuge only had one pseudoscorpion species in its checklist of more than 2,000 species. That morning, I accompanied Refuge Entomologist Matt Bowser and his son Ethan on a hike down the Gull Rock Trail near Hope. We crossed through Forest Service lands to reach a piece of rocky coastline along Turnagain Arm that is managed by the Kenai Refuge.

We timed the hike to ensure that the tide was totally out when we reached Gull Rock. Flipping over rock after rock and checking crevices that line the small tide pools, Ethan did indeed find the intertidal pseudoscorpion (*Halobisium occidentale*), a fantastic species we are proud to call a resident of the Refuge.

Outside the Kenai Peninsula, the Intertidal Pseudoscorpion is widely distributed on rocky North Pacific coasts from California to the Aleutian Islands.

The mission of the National Wildlife Refuge System is to provide a network of public lands and waters for conservation and management. Understanding what lives within our refuge boundaries is the first step in making educated management decisions. Finding this new species was very exciting and a great addition to our understanding of the complex ecological web on the Kenai National Wildlife Refuge.

So keep your eyes wide open for the incoming tide, and these little monsters that play their part in this big world to which we all belong.

Cade Kellam, an undergraduate student at the University of Alaska Fairbanks, is a biological intern this summer at the Kenai National Wildlife Refuge. Find more information at http://www.fws.gov/refuge/kenai/ or http://www.facebook.com/kenainationalwildliferefuge.

The lure of the North and where it led me

by Candace Ward

Retiring Park Ranger Candace Ward (center) with her dynamic colleagues—Leah Eskelin (left) & Michelle Ostrowski (right) in front of Majesty the Moose (back). Credit: Refuge Staff Photo

I first experienced the Far North in 1960 on a family road trip up the Al-Can Highway from California to Alaska. My father fixed up the back seat of our Dodge sedan with a wooden bench creating a wide bunk. With pillows and blankets, my sister Pam and I had a roomy travel nest in an era before seat belts and children's car seats.

The rumbling of the gravel road lulled us to sleep for most of the trip. My parents woke us whenever they saw wildlife. We would kneel on our bench gazing out the window to spy our first bear and moose. My most vivid memory is stopping at Portage Glacier and lifting small floating ice bergs from the water. Pam and I built "play" ice sculptures until our hands were so numb we couldn't move them.

After this trip, I formed a fascination with northern lands. I loved sitting with my dad pouring over National Geographic maps planning our "future" adventures. My next one took quite a few years to realize. I was fortunate in 1972 to be a high school foreign exchange student to Norway. With its steep mountains and deep glacial fjords, Norway made a deep impression on me, especially on hiking outings identifying wildflowers or gathering wild berries. I definitely fell even more in love with the Northland after this experience.

In 1974 while in college, my husband Walter and I had an unparalleled opportunity to do a field internship in the then-proposed Lake Clark National Park. Working with the National Park Service Alaska Task Force, we set up food caches with hospitable bush families to resupply us on our 2½ month kayaking and hiking treks. The goal was to share our experience "recreating" in the proposed park, recommend future park boundaries, and to relay to the National Park Service what recommendations local bush residents had regarding the future park.

We kayaked the Tilikakila River from Summit Lake through Lake Clark to Nondalton and then hiked from the Kijik River to Telaquana Lake with a wonderful

stopover at Twin Lakes. We hiked and visited with the legendary Dick Proenneke, whose photographic work was instrumental in getting recognition that the Lake Clark area was truly a gem worthy of national park status.

We went on to work as backcountry rangers with the National Park Service at Dinosaur National Monument in Utah and Colorado, and then at Mt. McKinley (now Denali) National Park with Walter in law enforcement and me in visitor services. In the late 70's and early 80's, we also worked as rangers for the California State Park System in several coastal and redwood mountain parks. We kept looking for opportunities to return to Alaska on a permanent basis. Fortunately in 1984, Walter was hired by Alaska State Parks where he eventually became the first District Ranger for the Kenai River Special Management Area.

In early spring 1984, I began volunteering for Kenai National Wildlife Refuge. In May 1984, I lucked out when the Refuge hired me as a leader for the Youth Conservation Corp (YCC). YCC was an amazing way to experience and serve the Refuge and the community through youth service projects. Highlights included restoring the Seven Lakes Trail along Engineer Lake, clearing Refuge ski trails by Headquarters Lake, and building a series of docks to help canoeists access the Swanson River Canoe Trails.

A part time permanent field ranger position opened up for me in August 1984. After attending law enforcement training at the Federal Law Enforcement Training Center, I divided my time between field patrols of the Refuge and giving education and interpretation programs. Over the years, I transitioned out of law enforcement to full time management of the Refuge's Visitor Center and Environmental Education/Interpretation programs. I had the opportunity to grow these programs with the assistance of seasonal staff and, ultimately, was successful in adding two permanent staff positions to the Refuge Information/Education Program.

I am deeply grateful for a rare combination of wonderful staff I have worked with over the last 33 years, a series of encouraging supervisors, and a welcoming and supportive community. I have had the pleasure of supervising and coordinating the work of over 300 volunteers, interns and staff in the Refuge Information/Education Program. Each one has contributed to improving and growing our program to help visitors and local community members learn more about the importance of the Refuge and the wildlife it protects as well as giving us "locals" a spectacular backyard in which to recreate.

I especially treasure the long term working relationships I have had with my permanent staff—Education Specialist Michelle Ostrowski and Park Ranger Leah Eskelin. Both Michelle and Leah started out at the Refuge as Student Conservation Association interns, then seasonal staff, and finally as permanent staff. I have worked with Michelle for 20 years and Leah for over 10 years.

Michelle and Leah are my two "right arms." We are a dynamic team that seeks to do our utmost for the Refuge, our community, and summer visitors. We host a variety of popular environmental education and interpretation programs and manage the Refuge Visitor Center and Environmental Education Center. We direct the work of summer seasonal staff members who work in the Visitor Center, give education/interpretation programs and patrol and do projects "in the field" on the Refuge.

I appreciate that over my 30-plus-year park ranger career at Kenai Refuge I have been allowed to grow and take on a wide variety of projects and responsibilities. One of my toughest challenges was the creation of our new Visitor Center which opened in May 2015. Our old center had served the community well for over 35 years. The new center with its welcoming lobby, spacious multi-purpose room, and state of the art exhibits is a wonderful attraction for visitors and a year-round benefit for our local residents. To have helped shepherd such an amazing legacy project is deeply gratifying.

Wow—and now it's time to retire. I look forward to outdoor adventures in Alaska and Outside with my husband Walter, family and friends. Like many retirees, I have "downsizing" projects of all sorts. I will enjoy staying connected to the Refuge now as a volunteer (which is how I started) helping with special projects and events. With the Refuge as my big backyard, I will treasure more free time to hike, canoe, and snowshoe—always appreciating its beauty and my great good fortune to have had such an exceptional career at this remarkable Refuge.

Candace Ward retires at the end of June 2017 after 33 years as a federal park ranger with the Kenai National Wildlife Refuge. For the last 25 years, she had led the Refuge's Information/Education Program. Find more information at http://www.fws.gov/refuge/kenai/ or http://www.facebook.com/kenainationalwildliferefuge.

A tale of two birches

by John Morton

A pressed herbarium specimen identified in 1941 as Kenai Birch by Eric Hultén, the author of Flora of Alaska and Neighboring Territories *(source: Smithsonian Institution).*

Did you know there are two species of native birches on the Kenai Peninsula? Well, actually three if you count the dwarf birch (*Betula nana*), a common shrub in many of our wetlands. But I'm focused on our two birch trees, the Alaska Birch and Kenai Birch, either of which you might mistakenly think is the same Paper Birch (*B. papyrifera*) that canoes were made from in *Last of the Mohicans* (and also happens to grow in Southeast Alaska).

The Alaska Birch (*B. neoalaskana*), despite its name, is not constrained to Alaska but grows over much of the boreal forest from Norton Sound eastward across Interior Alaska to western Ontario. Here on the Kenai Peninsula, Alaska Birch is most common on the northern half.

In contrast, the Kenai Birch (*B. kenaica*) is very much an Alaskan species, growing south of the Chugach Mountains and west of Prince William Sound and the Cook Inlet including the Alaska Peninsula and Kodiak. There are some reports of it growing in west-central Yukon Territory, but most of the evidence suggests it is endemic to south-central Alaska. Kenai Birch is most common on the southern half of the Kenai Peninsula.

Kenai Birch was first described by Walter Evans in the Botanical Gazette in 1899. Mr. Evans reported this new species growing in Sunrise, back when it was a thriving mining town on Turnagain Arm. It was locally known as red or black birch, generally growing in association with Sitka Spruce. Interestingly, he observed that the trunks of old trees are dark and fissured, bearing "a striking resemblance to that of *Prunus serotina*" or wild black cherry. The following year, he found Kenai Birch growing in abundance at "Kussiloff" (aka Kasilof) and surmised that is was likely well distributed on the peninsula, at least on its western side.

Both species are forest trees that can reach heights of 80 feet and diameters of eighteen inches (Kenai) and 24 inches (Alaska) or more. Bark of mature trees from both species are generally white or off-white, but range widely from brownish to reddish to gray or white in the Kenai Birch, and from red to off-white (pinkish, grayish, yellowish) to strikingly white in Alaska Birch. Both species have ovoid to triangularly-shaped leaves. Both species occupy wet and dry habitats and varying soil types. I hope this is as confusing to you as it is to me. Dr. Edmond Packee, a forestry professor at the University of Alaska Fairbanks, notes the greatest difficulty in distinguishing Alaska's birches will be where Kenai and Alaska Birch overlap, which basically describes our situation on the Kenai Peninsula.

But here are some useful distinguishing characteristics. Alaska Birch has larger leaf blades generally more than 5 cm long with 5–18 pairs of lateral veins, and their apex tends to be acuminate (long taper to a

point). Kenai Birch's leaf blades are mostly less than 5 cm long with 2–6 pairs of lateral veins, and their apex tends to be acute to short-acuminate (see photo).

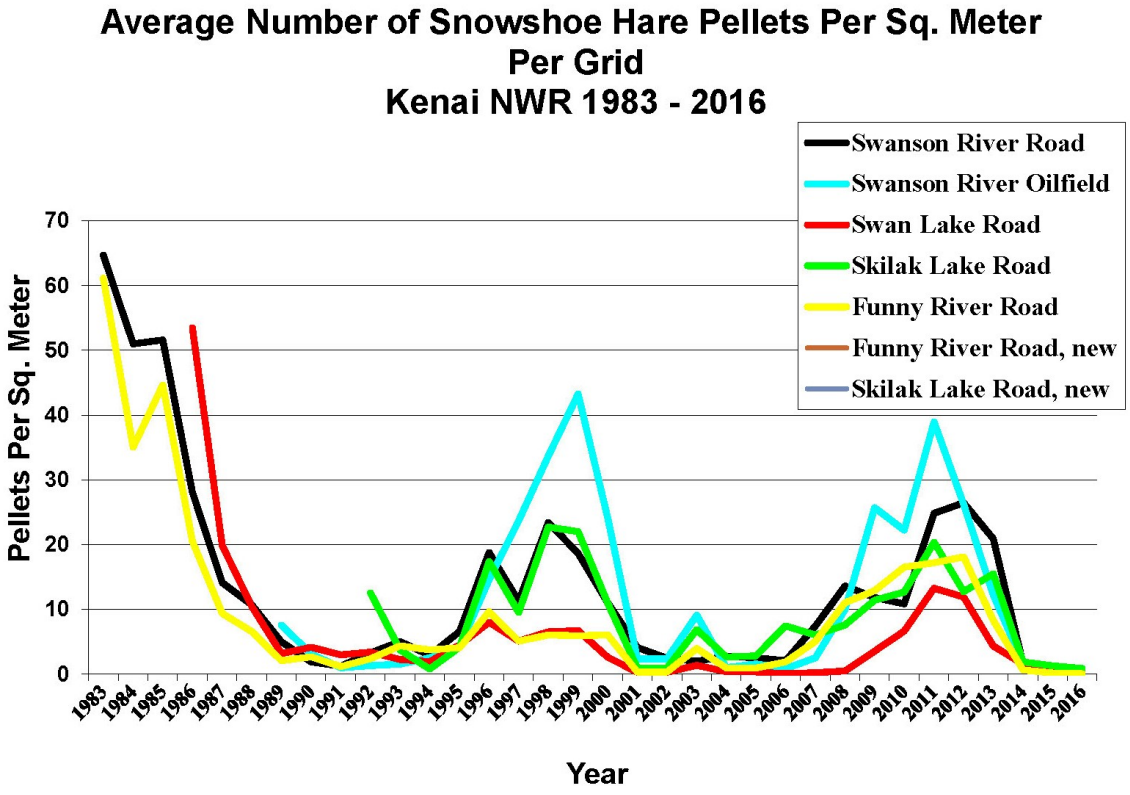
Another interesting difference is that the mature bark of Kenai Birch naturally peels in very thin layers, often admitting considerable light (translucent). In contrast, Alaska Birch's bark peels away easily in thicker layers that admit little or no light, and reportedly make better bark baskets and bowls.

Although overlapping in their distributions, their differences suggest that Alaska Birch prefers a more continental climate with colder winters than what our more regionally-adapted Kenai Birch seems to prefer, but not necessarily warmer summers as Kenai Birch is more common on the southern peninsula. Typical soil temperatures of birch stands around Fairbanks range from 48 to 52 degrees during the growing season, temperatures being exceeded now on the western Kenai Peninsula, more so near the City of Kenai than Homer. In our warming climate, it may be that Kenai Birch is favored over Alaska Birch on the peninsula. In more extreme climate scenarios, cottonwood, which prefers soil temperatures from 46 to 57 degrees, may be favored over either birch when soils are disturbed. Regardless, this will be tough to observe if you can't tell the difference between the two birch species.

Dr. John Morton is the supervisory biologist at Kenai National Wildlife Refuge. Find more information about Alaska birch taxonomy at https://www.uaf.edu/files/snre/Agro%2036-1.pdf. Find more information about the Refuge at http://www.fws.gov/refuge/kenai/ or http://www.facebook.com/kenainationalwildliferefuge.

The story behind snowshoe hare pellets

by Kyra Clark



Standardized pellet counts indicate where local snowshoe hare populations are in their 12–14 year cycle.

Few people are aware of a unique tradition that happens annually here at the Kenai National Wildlife Refuge. For the past thirty years only the luckiest of individuals have had the honor to take part in this important event and, this year, I was one of them. What is this tradition you may ask? It is the annual counting of snowshoe hare pellets. That's right, ever since 1983 the Refuge has been counting bunny poop!

In 1983, five grids were established on the Refuge to systematically count the pellets dropped by snowshoe hares. Each grid has 49 points that are spaced 200 feet apart. At each point, all pellets are counted within a square-meter metal frame that is placed on the ground. The pellets are thrown out of the sample frame as they're counted so, when we return next year, only the pellets accumulated during the year will be tallied.

The locations of these five grids were originally chosen to be in optimal snowshoe hare habitat. Much like moose, hares prefer early successional forests that regenerate in the first couple of years after a disturbance. Large wildfires in 1947 and 1969 provided Refuge biologists with several prime locations to survey for hares in 1983. After a half century, however, forests in some of these grids have matured past ideal hare habitat. So, in 2015, we added two more grids in

areas that recently burned.

Now to most people this may sound like grunt work interns are made to do, but the data we gather is actually really important. The pellet counts give us a clear image of snowshoe hare population abundance, which helps provide the demographic context for numerous other wildlife populations in our boreal ecosystem.

Snowshoe hare populations go through a predictable boom and bust cycle. Depending on where the populations are in that cycle clues biologists into many other things such as predator populations. Hares on the Kenai Refuge are prey for a large assortment of predators, most notably lynx, great-horned owl, and northern goshawk. Throughout Alaska and northern Canada coyote, golden eagle, red-tailed hawk, northern hawk owl, northern harrier, wolf, wolverine, red fox, pine marten, weasel, mink, and even squirrels, prey on snowshoe hares. The smaller predators can only prey on leverets, or young hares.

A pellet dropped by a snowshoe hare.

Most mammalian predators, like the lynx, follow the same boom and bust cycle as the hares but lag behind by a year or two. When the hare population begins to climb, more prey is available for the lynx. A year or two later the lynx population explodes in response to the abundant food supply. After hare populations crash and lynx no longer have enough food to support their population, they crash as well. The hares then have time to rebuild their populations and the cycle repeats itself.

This predator-prey relationship is certainly a major factor in the snowshoe hare population cycle, but it is not the only driving force. As populations increase there are more social stresses on the hares due to crowding and competition. Stress lowers snowshoe hare reproductive and survival rates. In the years of a population increase when predator pressures are still low, the average litter sizes decrease from 17 to 15 the first year and from 15 to 8 the second year.

Survival rates for both male and female hares also decrease during these first years of a boom. After the first two years of an ascending cycle, predator populations begin to increase and the combination of stress and predation and food depletion likely causes the hare population to crash. Studies have found that stressed females who survive till after the crash continue to have small litter sizes which may be one reason it takes five to six years for hares to reestablish themselves.

Based on the data we have collected since 1983, the hare population cycle on the Kenai Peninsula is 12 to 14 years. Most of the populations in northern Canada cycle in 10 years. The Refuge hare populations crashed in 2014, but recent sightings of hares dashing across roads suggest that hare populations are once again on the rise. When pellet counts are completed for this year we expect to see this hypothesis confirmed.

Next time you're out hiking on the Kenai Refuge, take a minute to squat by a tree and look for a round little turd, a sign that snowshoe hares were there before you.

Kyra Clark is a seasonal biological technician at Kenai National Wildlife Refuge. Find more information about the Refuge at http://www.fws.gov/refuge/kenai/ or http://www.facebook.com/kenainationalwildliferefuge.

Your photo can save salmon on the Kenai Peninsula

by John Morton

What to watch for! A strand of Elodea trying to hitchhike on a boat trailer from Sports Lake to another waterbody on the Kenai Peninsula.

So here's a riddle. What's green, likes water but travels by airplane, is freely passed around but is actually quarantined in Alaska, and has the potential to cost the commercial sockeye fishing industry almost half a billion dollars per year?

The answer is "Elodea", the first freshwater invasive plant to become established in Alaska. The Alaska Division of Agriculture did indeed quarantine two Elodea species and three other aquatic plant species commonly used in the aquarium trade and classroom labs in 2014. The quarantine orders that "it is prohibited to import, transport, buy, sell, offer for sale, or distribute plants or plant parts of the regulated species within the state of Alaska. It is further prohibited to intentionally transplant wild plants and/or plant parts of these species within the state of Alaska."

The problem is that the quarantine only addresses how Elodea was originally introduced into Alaska via aquariums. Now that there are established infestations, however, it is spreading to remote waterbodies by floatplane. Toby Schwoerer, with the University of Alaska's Institute of Social and Economic Re-

search, completed his doctoral dissertation this past spring on the bio-economic risks of Elodea spreading in Alaska. The likely scenario is that salmon habitat degradation due to Elodea consuming dissolved oxygen and providing cover for predatory fish (such as northern pike) will cost the sockeye industry almost $100 million annually. The worst case scenario modeled by Dr. Schwoerer suggests almost $500 million lost annually.

So the Kenai Peninsula Cooperative Weed Management Area (KP-CWMA) partnership has responded aggressively to local infestations of Elodea. It was first detected in Stormy Lake in September 2012 and subsequently found in two other Nikiski area lakes: Daniels and Beck. With great financial support from the Kenai Peninsula Borough and the U.S. Fish and Wildlife Service, KP-CWMA partners applied herbicides in 2014–15. The last Elodea to be found in any of those lakes was in September 2015!

This great outcome was soon tempered when Elodea was found in Sports Lake this past January. But KP-CWMA partners again rallied, hosting a public meeting on management options in April, petitioning for and receiving a permit exemption from the Alaska Department of Environmental Conservation, and applying herbicides in mid-May, two weeks after ice-out. The Alaska Department of Fish & Game (ADF&G) closed the public boat launch (except when monitored by staff) to minimize the likelihood that Elodea would be spread by boats and trailers using Sports Lake.

Last week we revisited Sports Lake to apply a bit more herbicide. Elodea has gone from occurring at 32 percent of sites surveyed in May to it now being detected as a couple of dying strands in only one deep hole. The boat launch is open again for public use with very little risk that Elodea will spread from Sports Lake to other local lakes. We fully expect Elodea to be eradicated completely from this lake by 2018.

The KP-CWMA partnership, composed of the Alaska Department of Natural Resources, Homer Soil & Water Conservation District, Kenai Watershed Forum, Cook Inlet Aquaculture, ADF&G, KPB, U.S. Fish and Wildlife Service and others, has done about as good and as fast a job as agencies can in responding to a true threat to our natural resources. Just this month, an article entitled "Rapid response for invasive waterweeds at the arctic invasion front: Assessment of collateral impacts from herbicide treatments" was published in the journal Biological Conservation that was authored by several biologists associated with the KP-CWMA.

But, again, our success to date is tempered by the knowledge that Elodea will almost certainly be reintroduced to the Kenai Peninsula from infestations elsewhere in Alaska. All known Elodea populations in the Anchorage area, including Lake Hood, have or are being treated. In the Mat-Su, however, treatments in Alexander Lake have been only partially successful, and Elodea was recently found in the nearby Sucker Lake complex. In Fairbanks, herbicides were applied last month in Chena Slough, but infestations now occur downstream in Chena River and the Totchaket Slough on the Nenana River. In Cordova, herbicides have been applied experimentally, but more serious management has yet to begin there.

We continue to survey and re-survey lakes here on the Kenai Peninsula, fully expecting to find Elodea again. At the Kenai National Wildlife Refuge, I continue to get calls from concerned citizens who are lending their eyes to this search. If you think that Elodea is growing in your lake, please take a photo of the plant (in your hand, not in the water) and contact the Refuge or any of the other KP-CWMA partners. We really do need all eyes on deck to keep Elodea from re-establishing on the peninsula.

Dr. John Morton is the supervisory biologist at Kenai National Wildlife Refuge. Find more information about the Refuge at http://www.fws.gov/refuge/kenai/ or http://www.facebook.com/kenainationalwildliferefuge.

The bad biter *par excellence*

by Matt Bowser

Biting snipe flies on the face of a sedated mountain goat, Kenai Mountains, July 13, 2017. At the same time the flies were attacking the attendant biologists in comparable numbers. Photo credit: Dom Watts/USFWS.

On a glorious, sunny day years ago after biking up the Resurrection Pass Trail to Juneau Lake, my companion and I paused to enjoy the spectacular alpine view and cool breeze by the water. The initial tranquility was brief. Within minutes, tens of flies the size of house flies landed on us and, with little delay, bit. These were unlike sneaky mosquitoes or black flies that can often take a blood meal without being detected; these things hurt!

Our encounter was not unique. A friend recently sent me a text regarding an experience in the Kenai Mountains asking, "what are those biting flies up in the alpine? … Looks like a regular ol fly but bite like hell."

We had become acquainted with the Kenai Peninsula's least famous biting flies, known by the names of biting snipe flies, blood-sucking snipe flies, Rocky Mountain biting flies, and names not suitable for printing in the newspaper.

Biting snipe flies can be found in parts of Europe and Asia, but this group is most diverse in western North America, where they live in montane and coastal meadows. On the Kenai they are encountered almost exclusively in wet alpine or subalpine areas. The adults usually appear only for a few weeks in mid to late summer.

Females readily take blood from humans, dogs, livestock, and game animals. They have been described in entomological literature as "vicious biters" with bites that are "rather painful" to "savage." Even among other biting snipe flies, the species commonly encountered in the Kenai Mountains was described by entomologist John Aldrich in his 1915 review of North American biting snipe flies as "the bad biter *par excellence*."

Biting snipe flies alight unobtrusively on people and may crawl under clothes before biting. When numerous, these flies can form audible "following swarms" around potential hosts, which may be the reason for their scientific name of *Symphoromyia*, which means "accompanying flies."

Their combined behaviors of persistent harassment, crawling on skin, and painful bites have been known to cause panic in some people, even in entomological researchers. During a study of snipe flies in Alberta, one observer, "draped an insect net over his head, slapped frantically at the assembled flies, and finally had to leave the observation area."

Reactions to snipe fly bites vary, ranging from no reaction to more severe inflammation, even leading to hospitalization in one documented case. In general, their bites are painful and may persist for days. In my personal experience in the Kenai Mountains, the initial bites were keenly painful, but I did not experience any lasting inflammation or itching.

As with other flies that take multiple blood meals, it is conceivable that biting snipe flies could carry pathogens from animals to humans or among people, but no case of disease transmission by these flies has been documented to date.

When pursuing horses, cattle, goats, and deer, a female snipe fly generally does not buzz around, instead landing directly on the host's head without de-

lay. Feeding is concentrated on the face and ears, with most bites taking place on the bridge of the nose. Developing antlers of male deer are also a favored feeding site. By angling their bodies upwards when feeding, snipe flies are able to get past the dense guard hairs of their hosts in areas where other biting flies have difficulty.

When attacks are severe on mule deer, bare spots may appear on face and ears. The deer respond to biting snipe flies by ear flicking and sometimes wiping the flies off of their faces, but the flies do not appear to stress them greatly. Interactions of biting snipe flies with other wildlife species have not been well studied.

Male biting snipe flies do not take blood. They aggregate in swarms to which the females come to mate.

Habits of the larvae of *Symphoromyia* are poorly known. The slow-moving maggots live in damp soil where they are at least partly predaceous. In a laboratory setting, Alaskan biting snipe fly larvae fed on other fly larvae and were even cannibalistic, piercing their prey and feeding on the innards.

Very little research has been done on ways to control or cope with biting snipe flies, perhaps because they are usually encountered only locally, the females are active for only a short time, and they are not known to transmit disease. For example, I could find no information on effectiveness of insect repellants for thwarting their attacks.

If you find yourself being hounded by biting snipe flies, I recommend following my example. When my friend and I were attacked at Trout Lake, we hopped back on our bikes, soon leaving those pestiferous flies in our dust. As vicious, painful, and often cursed as they may be, I am thankful that our biting snipe flies tend to be a passing nuisance that can usually be left behind.

Matt Bowser serves as Entomologist at the Kenai National Wildlife Refuge. You can find more information at http://www.fws.gov/refuge/kenai/ or http://www.facebook.com/kenainationalwildliferefuge.

What's up with the black squirrels?

by Dawn Robin Magness

A black squirrel residing at the Northern Peninsula Recreation Center this summer (credit: Rachel Parra).

A black squirrel is hanging around this summer. I became aware of this strange little creature when a picture from the Northern Peninsula Recreation Center popped onto my Facebook feed. I had never seen anything like it. We only have two species of tree-dwelling (arboreal) squirrels in Alaska: the American red squirrel and the northern flying squirrel.

Here on the Kenai Peninsula, that number drops to one because flying squirrels have not made it across the isthmus to populate our area. Our red squirrels are also influenced by the peninsular geography. Kenai red squirrels are isolated enough to qualify as a unique subspecies (*Tamiasciuris hudsonicus kenaiensis*), one of 25 subspecies distributed across North America.

I would guess that almost everyone living on the peninsula has seen a red squirrel. They are quite conspicuous or even obnoxiously loud as they defend their territories. Red squirrels cache piles of pine cones and chatter alarm calls when bothered by intruders. They are agile climbers and easily observed racing across tree branches.

Red squirrels are also easy to identify. They are small as compared to other squirrels (though we don't have to distinguish them from other species). The back-side of their bodies is reddish brown to olive-grey. Their bellies are white to buffy colored and they have a distinct white eye ring. In the breeding season, red squirrels have a black racing stripe that separates their red and white coloring. So what is going on with the black squirrel? The answer is melanism.

Melanism refers to mammals that are born with black or very dark brown coats. This phenomenon occurs in many squirrel species. For example, black individuals have been documented in Arctic ground squirrels and yellow-bellied marmots. Melanism has a genetic basis. A genetic mutation has been identified in grey squirrels whereby melanistic grey squirrels are missing a piece of gene that is involved in producing the pigments that color fur. They cannot turn off production of those pigments that make black fur to make white or orange fur. Grey squirrels that inherit the mutated gene from one parent are dark and those who inherit the mutation from both parents are black. Aside from the genetic mutation that produces dark fur, a melanistic animal can still interact and mate with other squirrels.

Genetic mutations occur, but they only become common in a population if they give the individuals that have them an advantage. Squirrels with black fur may be able to absorb more heat from the sun giving them a thermal advantage in cold environments. Black fur could make an animal less likely to be spotted by predators in a dark forest canopy.

Melanism is taking root in populations of grey squirrels. Black grey squirrels are common to see in Chicago. Grey squirrels are from North America, but invaded Britain in the late 19th century as squirrels escaped the cages of collectors. The first melanistic grey squirrel was spotted in Bedfordshire County in 1912. Within the past century, black squirrels have become common in Bedfordshire and have shown up in a wider geographic area.

Melanism is reported to be relatively rare in American red squirrels. Dark individuals have been documented in New York, Yukon and Nova Scotia, but melanism has not become common in these populations. The scientists reporting on the melanistic red squirrel in Nova Scotia speculate that perhaps being dark is not advantageous because their bodies are too

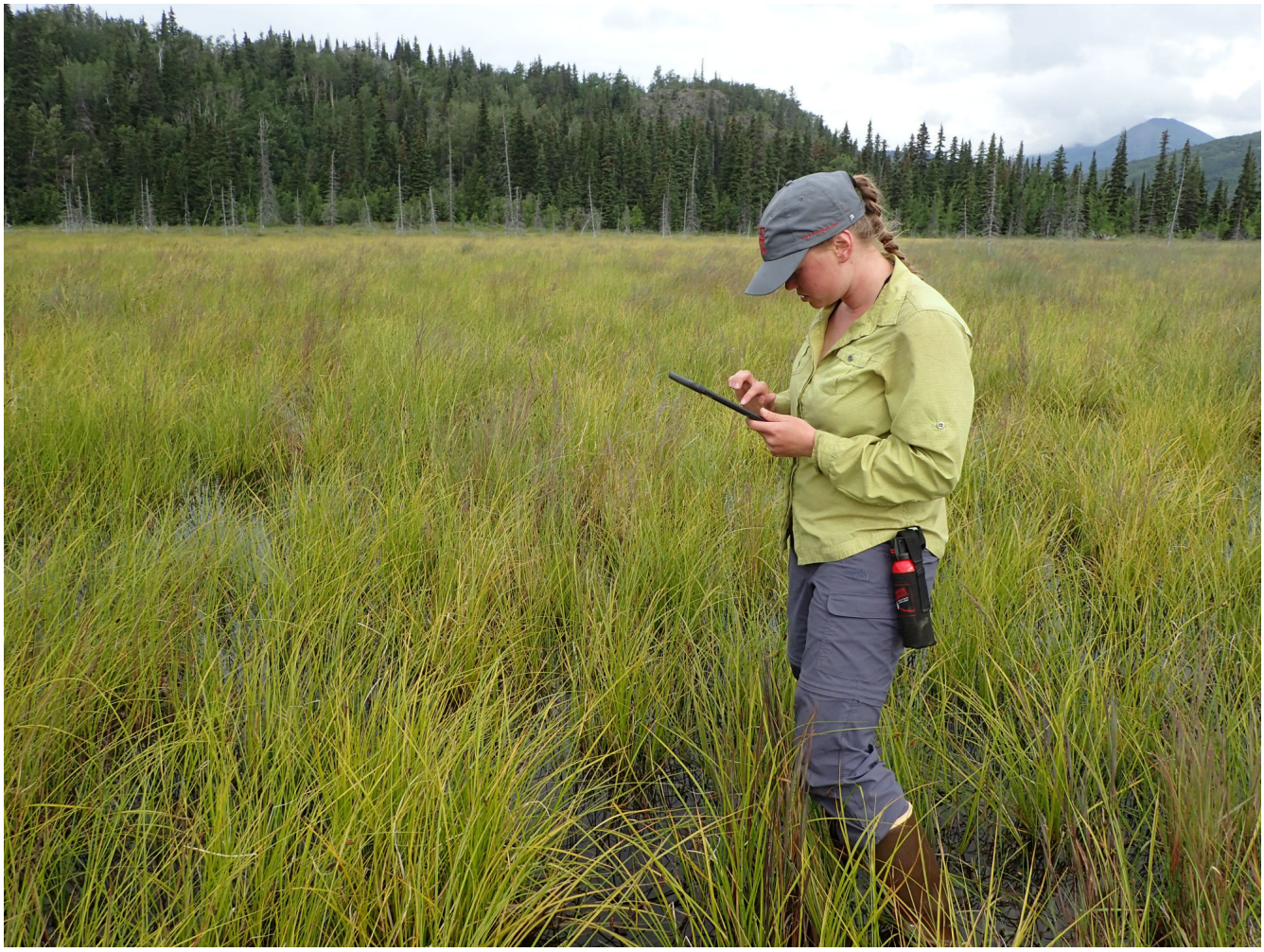
small to hold much heat and red squirrels deal with cold winters by restricting activity and staying under the snow.

I've been asking everyone I run into if they have seen black squirrels on the Kenai. Besides the squirrel at the Rec Center in Nikiski, I've heard credible reports of a black squirrel on Marathon Road in Kenai and at the Kenai golf course. Perhaps we will see our local population of black squirrels increase or perhaps they will blink out.

Dr. Magness is the landscape ecologist at Kenai National Wildlife Refuge. Find more information about the Refuge at http://www.fws.gov/refuge/kenai/ or http://www.facebook.com/kenainationalwildliferefuge.

What's covering the Kenai Peninsula?

by Mary Thomas



Emily Thomas, a biological intern at Kenai National Wildlife Refuge, enters vegetation data into an iPad (credit: Matt Bowser).

When most hikers reach a summit, they look out over the landscape before them to capture that point in time. They pull out their camera or phone to get the best shots from their new vantage point. When I've been hiking recently, I look up into the trees to try to gauge what it looks like from the sky. I'm using an iPad, taking four pictures in the cardinal directions. It makes sense that my perspective is different because instead of looking for good views I'm helping remake a landcover map of the Kenai Peninsula.

Since July, the Kenai National Wildlife Refuge has been sending teams of biologists into the field to gather vegetation data at specific points. My partner and I started out at the end of the Swan Lake Road, with another team working from the Swanson River Road. We have since surveyed all roadside points in between, plus others in the Swanson River Oil and Gas Field, and along Skilak Lake Road.

Not all the points, however, are accessible from a road. Some are closer to lakes and rivers, so we use a boat to access those plots along the shores of Tustumena Lake and Skilak Lake. For several days, two

teams of two or three people leapfrogged each other around the lakes, surveying one point as the other team was dropped off to survey the next point.

From the spot where we jump off the boat or park the truck, we use a compass and GPS to navigate to our sampling points. These points can be as close as 200 feet away to almost a mile away, longer still if there is more than one point in that area. When it's more efficient to go from the first point directly to the second point, instead of returning to the vehicle, we sometimes hike over a mile to complete a series of points. But, of course, that means hiking through whatever terrain is between us and the next point.

Sometimes it's easy, walking through groves of "quakies" and birch trees. Other times it's more of a challenge, scrambling over fallen or burned logs, pushing through Devil's club, crawling under elderberry thickets, slogging through peatlands (which seems to be a favorite of whoever set the points) or scaling a rock face.

We begin flagging when we get to the point in order to delineate 50 feet, the radius of the circular plot we're surveying. One person walks the perimeter if it's difficult to see to make sure all the plants are included. After determining the slope and aspect of the plot, we estimate the percentage of the different species of trees, shrubs, forbs, grasses, ferns, mosses, lichens and deadfall within the 50 foot radius as would be seen from above by an eagle or, in this case, by high-resolution digital photography captured from a fixed-wing aircraft. The data are entered into Survey123, an app specifically designed for these surveys.

At the end of the day, all of the points that were surveyed are submitted to the Forest Service's Remote Sensing Application Center where they are compiled onto a digital map so the field teams can track what areas have been completed in real time.

Back in 2006, Lee O'Brien, a GIS expert with the Kenai Refuge, made a landcover map of the Kenai Peninsula. Since then, vegetation on the Kenai Peninsula has undergone dramatic changes from a rapidly warming climate, as well as from wildfires and spruce bark beetle attacks. This summer, biologists at the Kenai Refuge, along with their counterparts from the Alaska Department of Fish and Game and Chugach National Forest are joining forces to resurvey the Peninsula. The difference between then and now, a span of a bit more than a decade, is that this mapping effort is using high-resolution digital photography rather than satellite imagery.

Eventually, the analysis of the imagery, called a supervised classification, will be completed by software with unusual names such as RandomForest and eCognition. Before the supervised classification can model the data and create the map, however, there are about 1,600 points that need to be surveyed. The more accessible half of those data points will be obtained by foot and other, more remote plots by observation from a hovering helicopter.

The importance of having an accurate, up-to-date landcover map of the Kenai Peninsula can't be overrated. It is a corner stone for modeling wildlife habitats, assessing fire fuel loads, and evaluating land management by all agencies.

Mary Thomas is an undergraduate in Animal Science at Colorado State University who is doing a biological internship at Kenai National Wildlife Refuge. Find more information about the Refuge at http://www.fws.gov/refuge/kenai/ or http://www.facebook.com/kenainationalwildliferefuge.

Could you win the Alaskan lottery?

by Hydn McDermott-Johnston

Despite a broken and hanging jaw bone, this bear is still successful at catching salmon with the plunging technique.

Winning an Alaskan lottery is the ultimate experience of a lifetime. Although it may not be a lottery with a big cash payout, it does offer an incomparable wholesome experience into a bear's world for a few days. Applicants of this "lottery" may become lucky enough to win a trip to McNeil River State Game Sanctuary and Refuge. I was fortunate to indulge in this unbelievable experience for four days during peak bear viewing season in July.

McNeil State Game Sanctuary is a remote location on the western shore of Cook Inlet, an hour flight west of Homer, Alaska. The rich ecosystem of the McNeil area makes for the largest concentration of brown bears, unparalleled in the world. According to the Alaska Department of Fish and Game (ADF&G), the McNeil River area was designated as a wildlife sanctuary to ensure protection of this unique resource of wild brown bears.

Throughout my time at McNeil River, I was profoundly taken by the magnificence of this place and the diversity of untouched nature that is observable even from camp. During low tides, mostly family groups and sub-adult bears can be seen clamming or grazing on the nutritious sedge grasses. Observing cubs frolicking and rolling around made for great entertainment from the edge of camp. Occasionally the neighborhood red fox trots by with its latest victim, heading towards its den near camp, where fox kits can sometimes be seen playing. Although McNeil River is specifically known for bear viewing, it's such a great

opportunity to appreciate other wildlife as well.

Not more than a two-mile walk from camp takes you to the McNeil River Falls. As many as 10 permit holders accompanied by ADF&G staff go out on bear viewing trips each day. While out on these trips bears can come very close at any time. The 50-year success of this program is due to the careful efforts to maintain a neutral experience between bears and humans. By following the lead of our guides and keeping our party close together, the group is perceived as a single, large entity by approaching bears. By practicing careful and unaggressive movements, the bears respect our space as we do theirs.

Large brown bear boar taking a break near the McNeil River Falls viewing platform.

The viewing area at the falls offers no barrier between the bears and humans, truly making this a paramount experience. This is where the larger boars can be observed. There is something truly special about having multiple bears easily over 1,000 pounds walk within several feet of the gravel pad we stand on, not feeling the least bit afraid due to the known history of bear management in this very special area. It is captivating when a bear shreds a salmon apart within several feet of us. Even enthusiastic camera-phone users can get quality pictures due to countless close encounters with the bears here.

The highest count of brown bears at any one time during our visits to McNeil Falls was 56! A majority of the bears that roam the area are identified by nicknames that help our guides keep track of who's who. Their names reflect a unique combination of gender, size, color, specific scars, behaviors and distinctive qualities.

It is very interesting to watch the various ways that bears use to get a hold of a fish—from snorkeling, plunging and diving, to standing still in the water waiting for fish to swim up the falls. Some bears specialize in one or two techniques, while only a select few have been noted for having success with all the fishing methods.

Bear-on-bear interactions are also remarkable to watch. Some plead for fish from other bears, while others compete for them. It's hard to believe that nearly 30 hours of watching bears during my trip never got old. Even for a born and raised Alaskan, this place was unbelievably fascinating for me.

I have seized what I've learned from this wonderful experience, using these lessons to help educate the public about bears while working at Kenai National Wildlife Refuge. Of course, due to inevitable human habituation, bears that roam the Refuge are not comparable to the bears at McNeil State Game Sanctuary. Most bears on the Refuge have likely been negatively or positively affected by human activities in some capacity, therefore there is an increased potential for risk and negative encounters with human-habituated bears. Bears are smart animals and it is imperative to take the necessary steps to help keep them as "wild" as possible. Practicing proper stewardship of the land (and your property) alleviates the potential for bears to become human habituated and decreases the number of human-bear conflicts. What could you do to help keep our bears wild?

Hydn McDermott-Johnston is a seasonal Park Ranger for the Kenai National Wildlife Refuge and a lifelong Soldotna resident. Information about McNeil State Game Sanctuary and Refuge is found at http://www.adfg.alaska.gov. Find more information about Kenai Refuge at http://www.fws.gov/refuge/kenai/ or http://www.facebook.com/kenainationalwildliferefuge.

Another tourist flying through

by Cade Kellam

Caspian Terns, with their tell-tale coral red bill, were recently seen on Tustumena Lake in the Kenai National Wildlife Refuge (credit: Carol Griswold).

A cloudy morning on Tustumena Lake calms the gelid winds that can roar down off the glacier. As our boat heads east, our team of five biologists from the Kenai National Wildlife Refuge are preparing for the day's venture along the shore line. Water laps against the side of the boat, as we continue a project to map landcover types of the Kenai Peninsula. The crew sits silently finagling with our GPS units and iPads ready to beeline to our points.

Skimming over the wave-less waters of Tusty, a rare moment on this unforgiving lake, I look out starboard to see a large sleek bird making powerful steady wing beats. The large bird looks similar to an Arctic Tern often seen on the rivers and lakes of the peninsula. As the bird continues to keep up effortlessly with the boat speeding along, I notice that it lacks the scissor-shaped tail and smaller stature of Arctic Terns. Now very intrigued with identifying this mystery bird,

I fight the wind from the moving boat to make my way back to the cab where Todd Eskelin, a refuge biologist and local birding expert, informs me in excitement that it's a Caspian Tern, *Hydroprogne caspia*.

A Caspian Tern is a very rare sighting on the Kenai Peninsula. I fetch a pair of binoculars to get a closer view. By this time there are now three of the terns racing alongside our boat. Their long and slender wings cut through the air, while they beat them down repeatedly matching the lolling of the engine. With the birds being only about 40 yards away, I can make an excellent observation!

The bird leads with its stout dark red beak that faintly tips out in black, the most tell-tale feature of a Caspian Tern. Between wing beats I catch the ghost white underside. They hold their dark black legs high and tight to the underside of their body. The white extends from the nape to the belly, but becomes a grayish tint as it moves to the wings and dorsal side of the bird. A jet black cap extends just under the eye and around the head. The bird is fairly large, but still appears delicate in its structure. They are a masterful balance of power, speed, and endurance.

After digging further into literature about the Caspian Tern, I learned what a remarkable sighting it was to have that day. This species of tern is the largest of the tern species, having wingspans from 127 cm to 145 cm! Like most terns, Caspians are almost always found along coastlines, and have an extensive distribution from North and Central America to the northern reaches of South America. There are even separate migrating populations of Caspian Terns found in Africa, Northern Europe, the Middle East and throughout Asia.

The birds we see on our continent rarely make it up this far north during summer breeding season. The Caspian Terns we saw that day were merely lost tourists. The denser populations of Caspians are found on the east and west coast, and in the Great Lakes. Most of North America's Caspian Terns summer in Canada and migrate along our coastlines to winter in the southern U.S. and Central America.

The Caspian Tern breeding season runs from around April to June. Typically, the male will attempt to attract the female via head bobs and offerings of fish—not something I would suggest to the young (human) males of Soldotna.

Like all terns and most shore birds, Caspians are ground nesters. Their nests are typically composed of scrapes in the ground lined with small rocks and leaf litter. The Caspian Tern can be ferociously protective of their nests, dive bombing any potential predators with their spear-like beak! Another use of their thick beak is catching and tearing apart fish, which constitutes the majority of their diet.

Caspian Terns are an understudied species. Although we know about their basic biology and phenology, there is much to be learned about our feathered friend from the south. Caspians are said to be monogamous but, due to the little we know about them, I would speculate they engage in offsite copulation and promiscuity, both of which are common in similar birds. Making observations and asking penetrating questions are important attributes to becoming a better scientist and naturalist.

Whether out on Tusty, Skilak Lake, or just hiking, be sure to keep a vigilant eye out for our flying travelers. The presence of them and other fauna are one of many reasons that this state is so special. Alaskans know firsthand all about tourism, but do not forget to enjoy the ones who won't run you off the road too often.

Cade Kellam, an undergraduate student at the University of Alaska Fairbank, is a biological intern this summer at the Kenai National Wildlife Refuge. Find more information at http://www.fws.gov/refuge/kenai/ or http://www.facebook.com/kenainationalwildliferefuge.

The trick to counting mountain goats

by Dom Watts

Wildlife biologist Dom Watts (Kenai National Wildlife Refuge) and wildlife veterinarian Dr. Kimberlee Beckmen (Alaska Department of Fish & Game) fit a chemically immobilized female mountain goat with radio-collars and ear tags that will allow biologists to identify her and other individuals during surveys and collect a variety of biological information.

The dart was in and the helicopter veered off to give some time for the capture drugs to take effect. The 6 year old male mountain goat, hereafter known as goat "071701", bedded down in a great spot in the alpine tundra just over a minute later. We approached and got to work fitting him with a highly visible orange radio-collar and ear tags, and taking a variety of samples to collect information on diseases, parasites, and genetics within the population. This capture marked the beginning of an intensive study of mountain goats throughout the Kenai Mountains.

At first glance, counting mountain goats from an airplane seems pretty straight-forward. Just fly around in the mountains, count the obvious white blobs scattered throughout alpine meadows, and then tally them up at the end of the day, right? Well, as Philip Roth wrote in his book *American Pastoral*, "simple is never that simple."

Wildlife surveys are deceptively complex and there are many aspects of wildlife surveys that are not apparent. In the case of mountain goat surveys, the biggest factor is simply missing animals for one reason or another, which ultimately boils down to 'sightability', or the probability of detecting or missing an animal during surveys.

With wildlife surveys, you'll always miss a few and there will always be circumstances that result in missing some individuals on the landscape. Accordingly, surveys will almost never result in a complete census, or exact count, of the population and estimates will always be lower than the actual number of animals in the area. The key to interpreting estimates where some individuals have been missed is not only using a reliable and consistent survey method, but also having some way to account for missed individuals. Because these population estimates are the basis for management and conservation strategies, it is important for surveys to produce reliable information.

For mountain goats, which live in a diverse mixture of rocky slopes, cliffs, alpine meadows, alder thickets and even subalpine forests, the probability of observing an individual may vary with something as simple as what habitat the individual is standing in that day. A goat in an open alpine meadow is more likely to be seen than one bedded in the shade of alders or up in a tight rocky canyon with camouflaging snow fields. Larger groups are also more likely to be detected than smaller groups or individuals.

Temperature and light intensity can also influence sightability. On sunny days, goats are often more difficult to detect because they may be bedded in the shade of boulders or in dense brush and because the reflection of bright light on rocks can reduce their detectability. The list goes on… but the end result is that the seemingly simple task of counting goats is fraught with obstacles when trying to derive accurate estimates of population size.

In an effort to develop improved survey methods that take into account variation in sightability and missed individuals during surveys, the Kenai National Wildlife Refuge, Alaska Department of Fish & Game, National Park Service, Chugach National Forest, and Rocky Mountain Goat Alliance are working together to develop new methods for estimating mountain goat abundance.

The primary objective of our study is to develop a sightability-model using collared goats that provide a 'marked' or known segment of the population and the numbers of marked individuals either observed or missed during surveys. We also collect additional information from these marked individuals during surveys such as habitat type, group size, climatic conditions, and other factors that can influence the probability of detecting or missing these individuals. These data are then used develop a sightability model that, ultimately, will provide more accurate estimates of mountain goat abundance and trends in the Kenai Mountains.

During July 2017, researchers from the Kenai Refuge and ADF&G captured and fitted sixteen mountain goats with radio-collars. Capture efforts went well, especially given the relatively low goat densities that occur in the interior mountains of the peninsula where initial efforts were concentrated. Collared goats were distributed throughout several key areas to ensure representation of different habitats throughout the Kenai Mountains. Future captures during 2018–2019 will increase the number of collared individuals to more than thirty and expand the project into new habitats.

We fitted these initial sixteen goats with GPS collars that not only identify individuals during surveys, but also collect several locations per day and relay this information via satellites to provide real-time information on goat movements, survival, and habitat use. These collars are also equipped with a mechanism that remotely releases the collar as battery power wanes after several years of collecting intensive location data. Goats were also fitted with micro-VHF radio-collars that will allow us to continue monitoring their survival and reproduction, and continue collecting sightability data, long after the GPS collars have released. These and other data collected during this study will help to enable science-based management of goat populations on the Kenai Peninsula.

Dominique Watts is a wildlife biologist at Kenai National Wildlife Refuge. Find more information about the refuge at http://kenai.fws.gov or http://www.facebook.com/kenainationalwildliferefuge.

How invasive plants invade the landscape

by John Morton

Creeping Thistle, with its purplish flowers, has invaded the North Slope, 50 miles north of Atigun Pass in the Brooks Range.

I just returned from the Dalton Highway, a thousand-mile road trip from Soldotna that can take as long as you want. Sometimes I do this trip in a manic, coffee-infused 20-hour drive that's a little reminiscent of *Fear and Loathing in Las Vegas*. Other times I putz, camping wherever and whenever.

It was different this time. I hit peak flowering for White Sweetclover (*Melilotus albus*), an invasive legume native to Asia and Europe that was introduced to the American colonies in the 1600s, likely as cattle forage. Now, four centuries later, I couldn't help but notice its white flowers almost continuously marking the Alaska Highway for 700 miles between Girdwood and Coldfoot. Sweetclover was introduced to Alaska in 1913 as a potential forage crop and was foolishly cultivated to become more cold hardy.

What's troubling is that en route to the Brooks Range, the highway (and sweetclover) intersects some big river basins on both sides of the Alaska Range: Susitna, Nenana, Yukon, Kanuti and Koyukuk. Sweetclover seeds not only float well, but they prefer disturbed soils like those found on stream gravel bars, and so this becomes the means or vector by which this invasive plant can disperse across the landscape.

In 2008, University of Alaska researchers fed sweetclover seeds to moose held captive at the Matanuska Experiment Farm in Palmer. Turns out that sweetclover seeds pass readily through the digestive systems of moose (and cattle) intact and so can be carried inland, away from streams or roads. This is how sweetclover spread from its initial introduction on a farm to roads to streams and finally elsewhere

through wildlife.

I was stewing about this dispersal chain as I drove over the Brooks Range and down onto the North Slope. The high arctic is arguably the *uber* frontier in Alaska, a state often billed as the Last Frontier. Here, the flora are native and the ecosystems are natural. Yet, as the Dalton Highway swings towards the Sag River, 50 miles north of Atigun Pass, I spied a patch of bluish-purple flowers growing on a "restored" right-of-way that paralleled the road. Turns out these were the blooms of Creeping Thistle (*Cirsium arvense*), another Old World invasive also introduced to North America in the 1600s, probably as a contaminant in crop seed or ship ballast. Because it is not palatable to most livestock, Creeping Thistle is formally listed by several states, including Alaska, as a noxious weed. In fact, Creeping Thistle can be so problematic that control legislation was enacted as early as 1795 in Vermont and 1831 in New York.

So how did it get there? The northern-most infestation previously found in Alaska was at Stevens Village, 200 miles to the south on the Yukon River. While it's possible seeds were transported by "dirty" heavy equipment used in the restoration, it seems so unlikely in this case as Creeping Thistle is still not common in Alaska, constrained mostly to southeast and southcentral regions of the state. More likely it was transported in the "wattle" coiled nearby, a straw-filled tube used for erosion control. Presumably the straw originated from a hay field infested by Creeping Thistle far, far away from the North Slope.

If Creeping Thistle isn't eradicated very soon from this site of initial infestation, it will become much more difficult to eradicate from the North Slope. Its seeds can travel several kilometers by wind and, as every person who tends backyard feeders knows, sparrows and longspurs like thistle seeds and will disperse them across the arctic tundra.

The takeaway from this story is that dispersal vectors differ among species and they change as a given invasive species becomes established and better distributed. Consider how Elodea, the first freshwater invasive plant to make it to Alaska and the Kenai Peninsula, was likely introduced to our waters as an aquarium dump but is now being moved around the state by floatplanes, boats, stream flow and perhaps waterfowl. Many vectors are linear like streams and roads. But, in some cases, invasives can hop-scotch great distances across the landscape, hidden in dirty straw or blown by wind.

Abundant White Sweetclover lines the Dalton Highway at the Arctic Circle.

The good news is sometimes we can beat back invasives if we have defensible space. The whole reason the 700-miles of White Sweetclover starts in Girdwood rather than Soldotna is because partners in the Kenai Peninsula Cooperative Weed Management Area have made it their business to eradicate this legume (as well as Bird Vetch and Elodea). Chugach National Forest biologists have done a great job keeping the Seward Highway clean along the isthmus near Portage that connects the Kenai Peninsula to mainland Alaska. And just this week, Kenai National Wildlife Refuge biologists pulled sweetclover at the Cooper Landing Post Office. Please help by yanking sweetclover up if you see it and tossing it in a garbage bin or fire pit.

Dr. John Morton is the supervisory biologist at Kenai National Wildlife Refuge. Find more information about the Refuge at http://www.fws.gov/refuge/kenai/ or http://www.facebook.com/kenainationalwildliferefuge.

Mystery solved!

by Todd Eskelin

Large gulls congregate in a field off of Ciechanski Road in search of food.

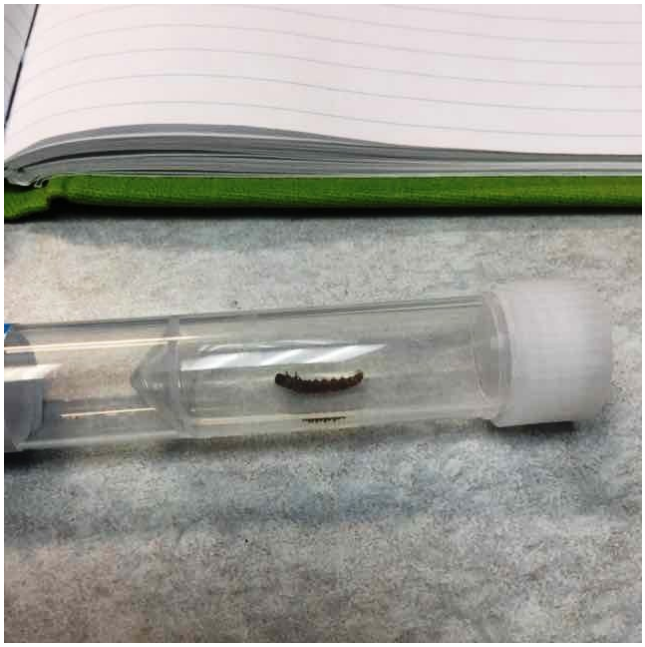
Earlier this spring, while passing a recently fallowed hay field, I noticed some large white birds wandering through the grass. At first glance, I thought these were early Snow Geese migrating through on their way to Siberia. I pulled over to investigate only to find that they were mostly *Larus* gulls. There were 37 of our typical Glaucous-winged × Herring Gull hybrid and another 12 Mew Gulls. This was puzzling. Along the field's edge were dozens of Robins as well.

The appearance of birds in the field is not unique, but these birds in these quantities had not been seen in the five years I had been driving by the field daily. What could possibly draw these larger gulls here to feed? My first thought was a new infestation of night crawlers or some large-bodied food source. These are big birds that usually don't bother stopping unless there are substantial calories to be gained.

As this event continued for several weeks, I could not let the question go unanswered any longer. I brought my spotting scope out to see if I could identify what they were eating. They were wandering through the grass and picking at something in the grass, but I still could not see what it was, even at 60 power. It certainly was not earthworms as there was no digging—

just pick, pick, pick, run to another spot and more picking.

I had to know! I jumped the fence and dropped to my hands and knees to try and spot a fat delectable bug that may be drawing the flocks of birds… nothing. I have seen this behavior with grasshopper irruptions, but there were no grasshoppers to be found. Next I broke out my sweep net and began scraping the 3-inch tall grass in areas where the gulls had been picking. I made about 10 swipes through the grass and found 35 tiny caterpillars in the bottom of my net. Could it be simply this tiny caterpillar about the size of long grained rice that in mass quantities was the gold mine?



The unknown caterpillar sent off in a LifeScanner vial was subsequently identified as Crambus perlella *from its DNA.*

Caterpillars can be relatively hard to identify morphologically, so we employed a relatively new technique using LifeScanner kits to identify them genetically. Several online libraries of DNA barcodes have been compiled and expanded by many contributors worldwide that form the basis for comparison with unknown samples. We have found the technique very successful—even identifying an insect from a single leg recovered from the stomach contents of a dead shrew (http://www.akentsoc.org/doc/AKES_newsletter_2017_n1_a05.pdf).

We suspected that the little non-descript caterpillar was the small white moth seen in grassy areas of the Kenai Peninsula last summer in epic numbers. After a long three weeks, the results were in and it was indeed this small white moth (http://boldsystems.org/index.php/Public_RecordView?processid=MOBIL4811-17). *Crambus perlella* or the Immaculate Grass-veneer Moth is a skinny white moth with a wingspan less than 1 inch. The forewing is "completely white with a satin lustre". The adults have one hatch and fly from late June to August, laying eggs at the base of various grass stems. The larvae overwinter in small silken galleries at the base of grass stems or even partially in the soil. In spring, they continue to eat grass stems and roots until they pupate and the next crop of adults emerges to start the cycle all over again.

This species has several defined subspecies and inhabit areas around the globe from northern Europe, Asia, Alaska, and Canada to as far south as British Columbia. While this innocuous little moth is easily overlooked by humans, it did not go unnoticed by the birds when conditions produced an immense proliferation of the species.

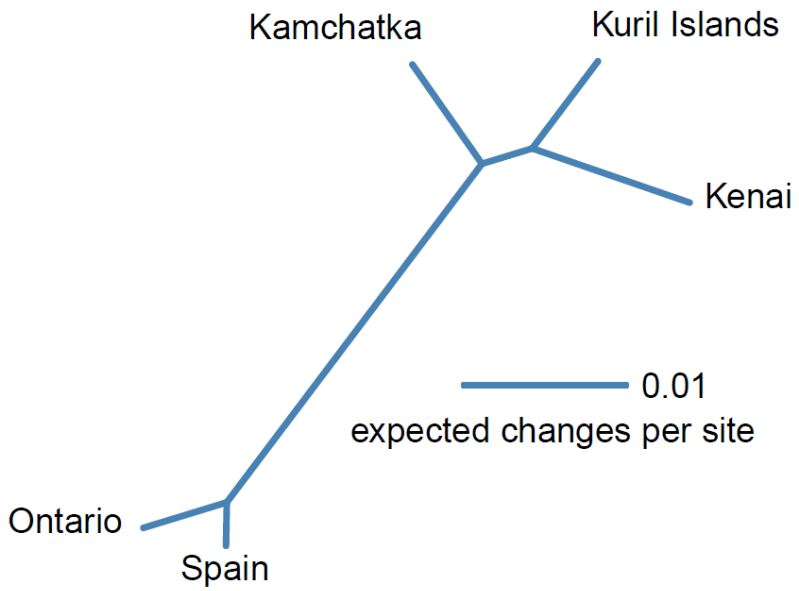
So, case closed for now. I am still fascinated by what may have triggered such a large irruption of this species the past two summers. Will this continue? How many years will we see these numbers of this species and will they persist at a level capable of drawing large birds to these fields? With the expansion of *Calamagrostis* on the Kenai Peninsula, will we continue to see more irruptions of *Crambus perlella*? They are always present, but at what point does their population become dense enough to make it energetically economical for large gulls to target them? Is there a density where even larger animals like black bears could target them like ant or wasp nests? Can their densities negatively affect certain grass species and, if so, does there preference for one species of grass give an advantage to other grass species?

As with most investigations, more questions often arise then answers. For now, I have been able to answer the most basic question of why these gulls were in the field. Only time will tell if this is a blip on our ecological radar or a sign of future changes to our landscape.

Todd Eskelin is a Wildlife Biologist at Kenai National Wildlife Refuge. He specializes in birds and has conducted research on songbirds in many areas of the state. Find more information at http://www.fws.gov/refuge/kenai/ or http://www.facebook.com/kenainationalwildliferefuge.

Revisiting big-ear radix snails on the Kenai Peninsula

by Matt Bowser



Genetic relationships among selected big-ear radix snails collected in several geographic regions. Longer branch lengths correspond to more differences among barcode sequences, measured in expected changes per amino acid site.

"Sometimes one thing leads to another." This is a quote from a *Refuge Notebook* article I had written about the Kenai Peninsula's first exotic freshwater snail, the big-ear radix (*Radix auricularia*), last January. I had been referring to the past, but more was to come. Soon after the article appeared in the *Clarion* I was contacted by retired geologist Dr. Dick Reger, who disagreed with statements in my article. He thought that this snail might be native.

As a geologist, Dick had studied freshwater snails and clams in old sediments in our area to determine past conditions. He had also collected and identified many local freshwater snail specimens, even putting together a draft field guide to the freshwater molluscs of the Kenai Peninsula. Based on what he knew of the present distribution of the big-ear radix snail in Alaska, he doubted that it had been introduced.

We dug into this question of whether or not the big-ear radix is exotic to our area. A literature search and expert opinion supported my first conclusion: the current understanding was that all populations of this snail currently in North America were the result of introduction from Europe.

The history of *Radix auricularia* in North America goes back to before 1869 when it was found near Troy, New York, apparently introduced with plants from Europe. By the early 1900s it had spread to multiple locations in the Great Lakes. Currently, this exotic species is still expanding its range in the western U.S. and Canada.

We had a new piece of information, though. Back in 2016 when we collected a big-ear radix from Stormy

Lake near Nikiski, we had sent off a tissue sample for identification by DNA barcoding, an inexpensive identification method using standardized, short sequences of DNA. We had received an identification of *Radix auricularia*, confirming our initial identification, but we had not examined the genetic data further.

These big-ear radix specimens were collected by Dr. Dick Reger from the stomach of an arctic char caught by Dan France at Fish Lake in 2005 and subsequently DNA barcoded.

So I compared the Kenai sequence with DNA barcode sequences of *Radix auricularia* from around the world that were publicly available through online databases. The barcode sequence from the Kenai Peninsula specimen was closest to sequences from Kamchatka and the Kuril Islands in East Asia, and less similar to sequences from Western Europe and eastern North America. A second DNA barcode sequence from another Kenai Peninsula specimen lent to me by Dick Reger matched the Stormy Lake sequence. The pattern suggests that in North America there are now two lineages of big-ear radix snails: one in eastern North America introduced from Europe and one native lineage in Alaska.

We now believe that the Kenai Peninsula population of *Radix* snails is a Beringian relict, one of many species in our region that have persisted from a time when parts of the Yukon, Alaska, and Siberia were connected and free of ice while much of northern North America was covered in glaciers. Based on the recent genetic data, our understanding of the provenance of the big-ear radix in Alaska has changed from exotic invasive to Alaskan endemic. Because this knowledge affects how this species is managed, it would be appropriate to follow up by obtaining DNA barcode sequences of *Radix* snails from other parts of western North America to determine if populations there are exotic or native.

We expect to have more complete information on the Alaskan big-ear radix population soon. In the summer of 2017 Dr. Ilya Vikhrev and Dr. Olga Aksenova, both from the Russian Academy of Science, collected freshwater molluscs (including the big-ear radix) from the Kenai National Wildlife Refuge and other places in Alaska as part of a study on trans-Beringian molluscs. Their team had already produced the DNA barcode sequences from Kamchatka and the Kuril Islands with which I had compared my sequences. They will be thoroughly scrutinizing the Alaskan specimens and their DNA sequences to better understand their relationships and history.

Learning through science is not always a linear process, but the unexpected is part of what makes this kind of work interesting. I will keep you posted when we learn more. I am especially grateful to Dick Reger for all his help and continued interest in this topic.

Matt Bowser serves as Entomologist at the Kenai National Wildlife Refuge. Find more information at http://www.fws.gov/refuge/kenai/ or http://www.facebook.com/kenainationalwildliferefuge.

What happens to herbicides after we apply them?

by Kyra Clark

Fluridone in SonarONE® is one of three chemicals used on the Kenai National Wildlife Refuge to kill invasive plants.

In 1962, Rachel Carson published *Silent Spring* in which the horrors of pesticides like DDT were exposed. Her legacy prompted both government agencies and chemical companies to be more cautious in how pesticides are formulated and used, but it has also made many people fearful or even paranoid about pesticides.

At the Kenai National Wildlife Refuge we are also wary of pesticides, but we do use them to manage some of the more than 110 exotic plant species introduced to the Kenai Peninsula. Over the years, we have been spot treating invasive plants at trailheads and boat launches, keeping the refuge noticeably cleaner than the rest of the peninsula. We typically use three chemicals: glyphosate, aminopyralid and fluridone. These are the active ingredients in the different commercial herbicides we use to control or kill target species.

The big differences between DDT and other pesticides used in Carson's time and those we use now are their environmental fate and how they degrade over time. DDT has a half-life (time required for half of the original concentration to degrade) of 2–15 years. DDT can also leach into water sources and bio-accumulate in the tissues of animals. In contrast, the three chemicals we use all have half-lives under a year, do not leach, and do not bio-accumulate in animals.

There has been a lot of bad press about glyphosate, but most issues with glyphosate products are associated with its use in agriculture where herbicides are applied chronically or genetically encoded into seeds. Glyphosate products vary in their formulations of glyphosate, the carrier solution, and surfactant. Surfactants enhance the active ingredient's effectiveness by breaking surface tension of the liquid herbicide to improve its coverage of foliage, its ability to stick to foliage, and its rainfastness.

We typically use two glyphosate formulations for terrestrial weed control on the refuge. Aquamaster® can be applied close to water. It is a liquid in which glyphosate comes as an isopropylamine salt and surfactants can be added. The more terrestrial formulation is Roundup ProMax®, another liquid but the glyphosate comes as a potassium salt and surfactants are already included. Interestingly the surfactants prepackaged in Roundup products, deemed "nonactive" ingredients and not regulated by U.S. EPA, are actually 100 times more toxic as cellular disruptors than glyphosate itself. Once we finish our current supply of Roundup ProMax® we will use Aquamaster® exclusively as our glyphosate product since we add a fairly benign surfactant called AGRI-DEX®.

Both Aquamaster® and Roundup ProMax® af-

fect only the emergent foliage to which it is applied. Glyphosate inhibits amino acid synthesis, which stops the production of three amino acids necessary to make enzymes and other proteins. Any glyphosate that reaches the soil binds tightly with sediment until it degrades by microbial action and so is not absorbed by roots. Its average half-life is 44–60 days in the soil. Because it binds so tightly with the soil, glyphosate is unlikely to leach into groundwater.

The other terrestrial herbicide we use is Milestone® with the active ingredient aminopyralid. Unlike glyphosate, aminopyralid remains active in the soil after application for the duration of the growing season so any target plants that emerge after the initial application will also be controlled. Aminopyralid does not move much in soil, remaining in the top 6–12 inches after application. Aminopyralid is a synthetic auxin (growth regulator). Its average half-life is 35 days in soil where it is primarily broken down by microbes. In water, aminopyralid is quickly broken down by sunlight (photolysis) with a half-life of less than 1 day. At the rate we apply Milestone®, 90% of the herbicide is gone from the soil in the first 90 days.

The only aquatic herbicide we use has the active ingredient fluridone, applied as both a slow-release clay pellet (SonarONE®) and as a liquid in an oil-based emulsion (Sonar® Genesis). This herbicide has been instrumental in our fight with Elodea, Alaska's only introduced aquatic invasive plant. It is applied at extremely low concentrations (<10 ppb) with a long contact time (45–90 days) that is lethal to Elodea but not so to native plants. Fluridone inhibits the biosynthesis of carotenoids, essentially shutting down photosynthesis. In the water column, fluridone is diluted by water movement, plant uptake, sediment adsorption, photolysis and microbial degradation. In sediments, after reaching its maximum concentration 1–4 weeks after treatment, it then degrades by microbial action.

At the Kenai Refuge our goal is to eradicate or contain invasive species, not just control their populations. We believe in detecting infestations early and responding quickly. Herbicides are one of the first tools we use, not because we are "chemical happy", but because they are generally the most effective tool when eradication is the goal. Treating early when infestations are small means we ultimately use less chemical with a greater likelihood of success. We are careful to use herbicides and surfactants that are both effective and have few secondary effects.

And a word to the wise: Always follow the instructions on the product label. Often times when herbicides don't appear to work, it's probably not the chemical. It's much more likely they were applied on an inappropriate species, at the wrong rate, during the wrong time in the growing season, or in the wrong weather. When in doubt, call the product manufacturer or Janice Chumley at the UAF Cooperative Extension Service in Soldotna (907-262-5824).

Kyra Clark is a seasonal biological technician at Kenai National Wildlife Refuge. Find more information about the Refuge at http://www.fws.gov/refuge/kenai/ or http://www.facebook.com/kenainationalwildliferefuge.

Secure natal dens are vital for many carnivorous mammals

by Ted Bailey

Remains of an aluminum soda can that was chewed on by wolf pups at a wolf natal den on the Kenai Peninsula (credit: Ted Bailey)

A hidden, secure place to give birth to and rear young is vital to many carnivorous mammals. This is especially true for solitary carnivores in the weasel, skunk and cat families where the mother must leave her young behind, alone and unprotected, for extended periods while she hunts for prey. These vital places are known as natal or "birth" dens. If the natal den is discovered by another predator or a human, the mother often moves her young, carrying them in her mouth, to a hopefully more secure place.

However, sometimes when she returns to the den she may discover her young have been killed by another predator. Males in the cat family sometimes practice infanticide, in which they will kill young they have not fathered so they can later breed with the female and leave his own offspring to survive rather than that of a rival.

When young solitary carnivores are mobile enough to follow their mother, she moves them about in her home range and leaves them in other secure places while she hunts nearby. Later still, the young may actually accompany their mother during her

hunting episodes. The same denning behavior generally applies to wolves although being social, rather than solitary carnivores, wolves have the added protection of other pack and family members to help feed and protect the pups.

Natal dens vary with the landscape and presence of other animals. Female striped skunks I once studied in a farming and marsh landscape often located their natal dens deep within old abandoned burrows dug by woodchucks. However, where farmers had eliminated woodchucks, striped skunks denned under old barns and sheds, discarded piles of lumber and sometimes under the farmhouse porch. In the treeless, sagebrush-dominated high desert on the basaltic eastern Snake River Plains in southern Idaho, female bobcats I studied selected small lava tubes, collapsed roof debris of large lava tubes, and small vents in the sides of ancient shield volcanoes as natal dens.

Interestingly, bobcats often shared their natal den sites with prairie rattlesnakes. One cave that female bobcats regularly used as a natal den was appropriately named "Rattlesnake Cave" where hundreds of rattlesnakes gathered each year to overwinter.

In South Africa, where I studied leopards, natal dens of females were difficult to locate in the densely vegetated subtropical "bushveld". I once narrowed down the location of one female leopard's suspected natal den to a dense patch of phragmites—a tall, dense tropical grass. One day when the female was away hunting, I safely examined the site. There I found the entrance to a burrow dug by an aardvark—a mammal with large claws that digs into termite mounds to feed—and assumed her kittens were inside. Then I witnessed a huge African python enter the aardvark burrow and within days the female abandoned the suspected den site and traveled widely each day, an indication she had probably lost her young. I often wondered if the python had made a meal of her small cubs.

Here on the Kenai Peninsula, I had the opportunity to examine the natal dens of lynx and wolves. Female lynx often have their kittens under fallen trees in almost impenetrable patches of mature forest characterized by dense stands of spiny Devil's club. One female had her kittens under a dense stand of fallen and burned black spruce trees burned during the 1947 wildfire. Another female had her kittens in the rocky terrain along eastern Skilak Lake on the Kenai National Wildlife Refuge. She happened to be caught in the May 1996 Hidden Creek wildfire which completely burned over the area where I suspected she had her kittens. Fearing she had perished in the fire, I followed her radio collar signal and hiked through burned debris into the rugged area several days after the fire had been suppressed. To my surprise, I found her and her young kittens alive and well under an overhanging rock cliff face that the fire had not reached.

Most of the wolf dens I examined were in burrows dug by wolves (or perhaps brown bears) in the sides of steep glacial moraines or under the root wads of large blown-down trees. One wolf den in a remote area was in a deep fissure along a fault line caused by shifting ground of the Great Alaska Earthquake of 1964. Interestingly, among the various chewed bones of prey scattered around the den site, I found what was left of a chewed-up aluminum soda can (Diet Coca Cola) that a wolf had apparently carried a great distance for the pups to play with and chew on. In my mind, I sometimes picture the wolf proudly trotting through the forest carrying an aluminum soda can in its mouth, intent on bringing the pups a novel item that it had found.

Dr. Ted Bailey was supervisory wildlife biologist at the Kenai National Wildlife Refuge before retiring in 2001. He has lived on the Kenai Peninsula for over 40 years. Find more information about the Refuge at http://kenai.fws.gov or http://www.facebook.com/kenainationalwildliferefuge.

Northern Groundcones—the cure for cancer?

by John Morton

Flowered spikes that look like erect pine cones are why this parasitic plant that grows in northern latitudes is called the Northern Groundcone (credit: Leslie Morton).

In the 1992 movie *Medicine Man*, Sean Connery plays a scientist who discovers the cure for cancer in a rare ant species in the Amazon jungle. This is frequently used as a vague argument for why we should do our best to sustain global biodiversity—after all, you never know when an unknown species might actually remedy an incurable disease.

So imagine my surprise as I was researching the life history of a local plant, *Boschniakia rossica*, that it actually has anti-carcinogenic properties. This plant is easy to overlook because it's very dark maroon to reddish brown, blending into the soil found beneath alders where it is typically found.

But, once you see it, you'll wonder why you never noticed it before. This perennial grows 6–12 inches tall, with two to three stems per individual. It gets its common name, the Northern Groundcone, because it looks like a cylindrical pine cone that somebody stuck in the ground and because it is native to the northern latitudes of our northern hemisphere in an area on either side of the Bering Strait called Beringia. It gets its scientific name from A.K. Boschniaki, an amateur botanist who also happened to be Russian (rossica supposedly means "of Russia"). In Alaska, it grows north of the Brooks Range and as far south as the Prince of Wales Island.

Here on the Kenai Peninsula, it is typically found in acidic, wet to moist soils generally associated with Green Alder. The groundcone does not contain chlorophyll, so it parasitizes the roots of alder and, much less commonly, those of birch, willow, blueberry and *Chamaedaphne* (leatherleaf). Groundcones produce haustoria or specialized roots that penetrate the host's tissue to draw water and nutrients from the phloem.

A tuber-like swelling or nodule can form where the roots of the groundcone and alder fuse, varying in color from whitish to dark brown. These nut-like nodules are bitter but edible raw or roasted. They are often dug-up by foraging bears. The flowered spikes that form the "groundcone" can produce up to 300,000 seeds. But if you're interested in sampling the nuts, be aware that the groundcone does not necessarily mark where the nuts are growing—they may be further away along the alder roots.

The Northern Groundcone has a long history of being a medicine among northern cultures. In some First Nations and Native American tribes the whole plant is dried, ground, and used as a topical application, and sometimes smoked in a pipe. The Dena'ina called it *qinaz'in*, or "that which sticks up". It is widely used in Chinese traditional medicine as a substitute for Cistanches Herba, a famous stamina tonic agent, and it reportedly prevents senility. Other traditional applications include cleansing and nourishing the kidneys in tonic form, curing impotence in men, strengthening the heart, easing constipation, alleviating skin rashes, increasing memory retention, and treating coughs. As it turns out, groundcones also contain chemical compounds that are attractive to cats and can induce the "catnip response".

The underground nut-like tubers of groundcones are eaten by people and bears (credit Matt Bowser).

But it is the phenylpropranoid and iridoid glycosides in groundcones that have pharmaceutical companies interested. These compounds are secondary metabolites that exhibit anti-inflammatory, anti-lipid, anti-mutagenic and anti-oxidative effects. For example, laboratory studies show that iridoids inhibit skin cancer in rabbits and the early stages of liver cancer in rats. Google "Boschniakia rossica" and "pharmaceutical" to see how much research on this plant's chemical properties have been generated since the 1990s.

So you (and drug companies) don't have to go to the Amazon to search for the cure to cancer. The Northern Groundcone is common on the Kenai National Wildlife Refuge, first catching my attention on the Skilak Lookout Trail last summer. Until the snow flies, its flower stalks can still be found near the trails around the Refuge Headquarters on Ski Hill Road.

Dr. John Morton is the supervisory biologist at Kenai National Wildlife Refuge. Find more information about the Refuge at http://www.fws.gov/refuge/kenai/ or http://www.facebook.com/kenainationalwildliferefuge.

Flying into the future

by Dawn Robin Magness

The American Redstart currently breeds in eastern United States and southern Canada, but climate warming may make the Kenai Peninsula a suitable place for it to live by the end of this century. (credit: S. Maslowski, USFWS).

I am jealous of birds. They fly. In my imagination, the mobility of flight would open up so many possibilities. The first bird found in the fossil record is *Archaeopteryx* that lived 150 million years ago. From this common ancestor came the great diversity of birds and flight strategies that we see today. Hummingbirds hover over flowers on wings designed to flap in a rapid figure eight. Albatross keep their heavy bodies in the air effortlessly without flapping their long wings.

Flight gives birds the ability to use seasonal resources that become available thousands of miles away. Swainson's Thrush born on the Kenai Peninsula migrate across the continent to winter in Central and South America only to fly back to Alaska to lay eggs. Evolutionary biologists theorize that these long distance migrations began as shorter movements. Individual birds that took advantage of seasonal resources that might be far away were more likely to survive and thrive. Over many generations, the movements of their offspring gradually become longer. Cycles of glaciation over the past 2.5 million years would have also facilitated longer and longer migrations as birds moved across North America following retreating ice sheets and then contracting their movements to accommodate surging ice.

Mobility helped bird species survive and take advantage of environmental and climatic changes in the past. The fossil record provides evidence that the ranges of many plant and animal species have shifted idiosyncratically during past climatic change. We expect that birds will continue to utilize their mobility as the climate changes in the future. Bird species are already shifting northward in response to contemporary climate change. However, birds seem to be responding slower than the rapid pace with which our climate is warming. Conservation biologists are also concerned that specific habitats, especially for birds that are specialists, may not move to align with the climate constraints.

The National Audubon Society is using climate envelope modelling to shed light on the conditions that birds may face in the future. Climate envelope models describe the conditions or "climate niche" in which a bird species occurs. In a 2015 paper, Audubon scientists modeled the current and forecasted future distributions of 588 North American bird species during the breeding and non-breeding season.

I worked with two of those authors, Chad Wilsey and Joanna Wu, to use these models to make educated guesses about which birds might colonize or be extirpated from the Kenai Peninsula over the next 100 years as the climate warms. The Kenai Peninsula is the southern extent of the boreal forest and the northwestern extent of the Pacific maritime rainforest. The boreal forest on the western peninsula is experiencing more dramatic climate change and, so, is forecasted to have more bird species "turnover" here than on the eastern side of the Kenai Mountains. The models suggest that suitable climate ceases to occur on the Kenai Peninsula for 45 species in the summer and 13 species in the winter by the end of this century. This list includes some bird species which are very common today on the Kenai Peninsula such as the Orange-crowned Warbler and Golden-crowned Sparrow. So far, we have no evidence that any bird species have disappeared from the Kenai Peninsula.

On the other hand, the climate is projected to become more suitable for 65 breeding bird species and 56 wintering bird species not found on the Kenai Peninsula today. For example, the models suggest that

Dark-eyed Juncos and American Robins will experience a more suitable climate for overwintering by the end of this century. We have solid evidence that both species occur almost year-round now when they used to only summer here 50 years ago.

Some bird species projected to have more suitable climatic conditions on the Kenai, such as the Spotted Towhee, would need to expand their breeding range up the Pacific coast. Suitable climates for other bird species that breed further east, such as the American Redstart, Northern Cardinal, and Blackburnian Warbler, are shifting westward across the boreal region of Canada.

We don't know the future. Refuge staff are just beginning to wrap our heads around how ecological communities may change in the future. We continue to adjust as new observations are collected.

Dr. Dawn Magness is the landscape ecologist at Kenai National Wildlife Refuge. Find more information about the Refuge at http://www.fws.gov/refuge/kenai/ or http://www.facebook.com/kenainationalwildliferefuge.

Relocation of the Darien-Lindgren Cabin

by Michael Bernard

Kids from the Kenaitze Indian Tribe Susten Archaeology Camp excavate around a historical cabin in preparation for it be moved by Gary Titus from the Kenai National Wildlife Refuge.

In 2012, I received a grant from the Kenai Mountains-Turnagain Arm National Heritage Area to develop an interpretive program for the Kenaitze Indian Tribe. My team and I interviewed relatives of Tribal Elder Herman Lindgren, who had helped his uncle, Eli Darien, build a trapping cabin in 1937 on the north bank of the Kenai River three miles downstream from Skilak Lake.

My first experience with the cabin was in the mid-1980s as a Boy Scout. Our troop hiked to the cabin for an overnight camping trip. None of us really knew much about the cabin but, at that point, it was still in good shape.

I didn't revisit the cabin until 2005, not long after I had accepted the role of the Kenaitze Tribe's Cultural Department Director. One of my responsibilities was to coordinate an archaeology camp with Debbie Corbett, an archaeologist at the time with the U.S. Fish and Wildlife Service. This was the first camp that I had coordinated in that position and, to this day, still ranks as my most memorable.

I had sent my staff and campers off to the Upper Skilak Campground to set up camp while I took care of some last minute details in town. I could see dark clouds and lightning flashes in the direction of camp and, when I finally arrived, everything was soaked from the storm but we made the best out of the situation. Unbeknownst to us the lightning had sparked a wildfire across Skilak Lake in the King County Creek area that would eventually consume 10,131 acres.

The next day, Gary Titus from the Kenai National Wildlife Refuge met up with us as we ferried our campers and gear by boat to the cabin. This was the first time that I had ever used the boat or had ever navigated that part of the river, so it was fortunate that Gary could guide me through the channels as the river was very low and there were numerous gravel bars.

The campers did some test pits and excavations around the cabin in preparation for it to be disassembled and moved by Gary's crew. It was already lunch

time by the time I had everyone at the site. The current was going to make the process longer to get everyone back up the river, so I decided to start ferrying back before it got late. That ordeal took us until dinner—lesson learned. That night the winds caused the fire to gain momentum and quickly crept towards the cabin.

We developed a new plan that involved me and a coworker hauling all our gear to the cabin by boat while the campers and staff hiked in by trail with Debbie. Unloading the gear from the boat, I noticed three messages on my cell phone from Gary at Refuge Headquarters. His first message went something like this: "Hey Mike, this is Gary. Give me a call when you get this message." His second message sounded more urgent. "Mike, this is Gary. I need you to call me right away." The third message, even more urgent than the first two: "Mike, call me. The fire is moving towards the cabin!"

When we finally connected, he suggested that we didn't spend too much time working around the cabin in case the fire picked up speed. As I hung up the phone I stood on the river bank looking in the direction of the fire and could feel the wind on my face. At that point I decided that we wouldn't stay. The campers had just arrived but, after a short break for water and a snack, I sent them back down the trail.

After they left, I called Gary to tell him that we were not going to risk it and were leaving. Robin West, Refuge Manager at the time, could be heard in the background talking with Incident Command and the directive was given for us to evacuate because the planes would be there in an hour to drop fire retardant. It wasn't 15 minutes later and the Canadair CL-415 roared overhead, just barely above the trees.

As the fire raged on, Gary's crew disassembled the cabin log by log. Over the next 24 hours, trip by trip, they transported the cabin by boat to the Lower Skilak Campground, each trip ferrying groups of firefighters downriver to the fire.

A few days later, campers and Tribal Members met with Gary and his crew to reconstruct the cabin at the K'beq' Interpretive Site located at mile 52.6 of the Sterling Highway. One of the many reasons this cabin has value is because it invests in the education of our youth about another unwritten part of our Native Culture and history in this area.

The site is now open for public viewing during June through August, from 10am until 4pm on Thursdays through Sundays. Come visit the cabin at its new location!

Michael Bernard is the Yaghanen Program Administrator for the Kenaitze Indian Tribe. Find more information about the Kenai Refuge at http://www.fws.gov/refuge/kenai/ or http://www.facebook.com/kenainationalwildliferefuge.

The Darien-Lindgren Cabin now rebuilt and restored at the K'beq' Interpretive Site on the Upper Kenai River.

Due dates for Kenai Refuge permits just around the corner

by Rebecca Uta

As I reflect on the last six months of the year, I'm appreciative of the absolute flurry of activity both recreationally and commercially here on the Kenai National Wildlife Refuge. I see a lot of the folks who come in to apply for permits, as well as most of the paperwork associated with this important but sometimes not-so-fun permit process.

How about your summer? If you are a commercial guide on the Refuge, the spring months were filled with collecting your annual business documents, visiting with our permitting staff at the Refuge Headquarters office on Ski Hill Road to pick up our colorful Refuge stickers, and then meeting your summer clients.

Now that the summer has flowed past us—the boats have been shored and wrapped, the planes are being fitted with skis and the trees are bare save for the spruce—the administrative work at the Refuge never ends. With the cold winds blowing down from the mountain peaks, the season of deadlines has arrived, and we have some lurking around the corner. Don't miss these dates or, as Douglas Adams said, "I Love Deadlines, I love the whooshing noise they make as they go by."

Mark your calendars:

- Commercial Client Use Reports are due November 15, 2017.
- Applications for new and expiring permits must be received no later than April 1, 2018.
- The Annual Trapping and Snare Orientation will be held Tomorrow, October 28, 2017, starting at 9 a.m. in the Environmental Education Center.
- Trapping on the Refuge Season Opens November 10, 2017. Permits are available now.
- Firewood Collection Permits are still available.
- Don't forget Subsistence Hunting Harvest Tickets—due dates do vary depending on season and personal harvest date.

Remember these dates! It'll help your upcoming season start without a hitch so you can get out and fish or float or fly or hunt… or outfit, as the case may be.

Here's some Refuge trivia: On an average year, we process well over 500 permits. These permits cover the most recent activities (firewood collection and trapping), to on-going annual commercial guiding and industrial activities on lands leased to commercial oil & gas operators, as well as collaboration with our right-of-way permittees and in-holder access programs, just to share a few slices of the permit pie.

Interaction between our community and program administrators occurs most often through our front desk. The permit technician will usually be the one to greet you with a kind hello and a smile, while waiting to hear how we can help find what you need. A large percentage of time, you will work solely with our administrative staff, as small as it is with a total of two, sometimes three individuals.

You do not need a permit to enjoy the Refuge for a personal recreational activity such as camping with family and friends or hiking any of our trails. However, if you engage in any commercial activity such as guiding, film-making, or providing commercial transportation, or if you propose to conduct scientific or geological research or other non-recreational activities, a Special Use Permit is required.

Call the Refuge Headquarters with any questions or concerns. Alternatively, check out our website under the Kenai Refuge Permits page (https://www.fws.gov/refuge/Kenai/visit/permits.html). Here, you can learn about the general permitting process and get most questions answered about our permits.

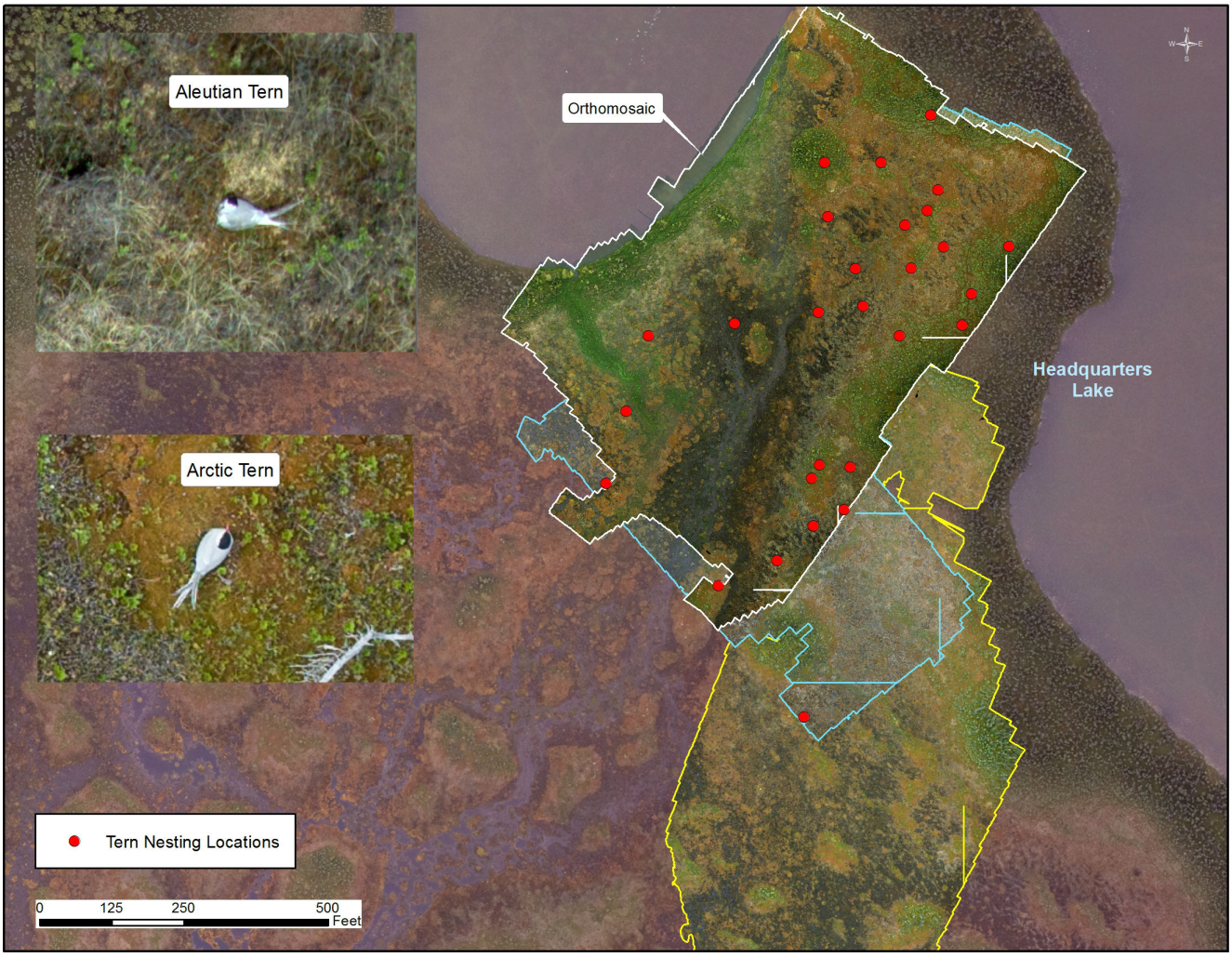
Speaking of the color of our permit stickers, I always wondered if there is a pool amongst the guides to guess what this year's colors might be and if anyone ever dreads when pink might come back. Our local office has had some changes and I will be selecting the color scheme this year. It might be a tied-dye year—maybe not… camo? Pink camo. Maybe hot neon pink! I digress. I don't think those colors are in our selection palette.

Continue to have fun out there this coming winter and don't forget our administrative folks at the Kenai Refuge Headquarters office.

Rebecca Uta is the Administrative Officer at Kenai National Wildlife Refuge. Find more information about the Refuge at http://kenai.fws.gov or http://www.facebook.com/kenainationalwildliferefuge.

An unmanned survey of a tern colony

by Mark Laker



Single image mosaics were created from the hundreds of photos taken during multiple drone surveys. Distinguishing Aleutian from Arctic Terns based on bill color was possible from photos taken 50 feet above the ground.

A small breeding colony of Arctic and Aleutian Terns nests by Headquarters Lake, a convenient 15-minute walk from the Kenai Refuge office. For several years, the colony has failed to produce any young. Little is known about Aleutian Terns, which have declined dramatically in recent decades.

Early in the field season, we did a pilot project to explore using a drone, or Unmanned Aerial System (UAS), to count nesting Aleutian Terns. Using the UAS, we hoped to find a more efficient way to survey without adversely impacting them in the process.

Two questions we wanted to answer. The first was whether flying our small quadcopter over the colony would disturb nesting terns. The high sensitivity of nesting Aleutian Terns to human disturbance was a major motivation for using UAS to remotely survey the colony. Any sign of negative disturbance, such as birds flushing from the nest and leaving or attacking the UAS, would obviously discourage their use. Secondly, we wondered if Aleutian Terns could be distin-

guished from Arctic Terns in the processed imagery. These two species look very similar, but Aleutian bills are black and those of the Arctic are bright red.

After test runs in May, we flew the first survey 100 feet above ground level (AGL) on June 7th. The terns had been there for several weeks and probably started incubating the week before. We wanted all potential pairs to be incubating before the first flight, as it would be difficult to observe disturbance effects on terns prior to nesting.

During the first flight, terns ignored the UAS, and the terns showed clearly on processed images. Though we couldn't distinguish species, we were comfortable letting the UAS get a closer look at 75 feet AGL. Again the terns ignored the UAS and you could see terns much better in the imagery.

I was ready to call it a success, but the true birders on the project, Dawn Magness and Todd Eskelin, were not convinced. Though the images were teasingly good, my colleagues were not ready to make a definitive identification. I understood—if you want to be a respected birder, it's best to set a high bar.

Our colony nests in a complex of wetland, grass and shrub habitats. Getting close enough on foot to a nesting tern to pinpoint their cryptic nest and well-camouflaged eggs is very difficult. However, from above, nesting adult terns are conspicuous, especially if you happen to be an eagle. When threatened by avian predators, the terns flush from the nest and give chase, noisily driving the intruder away with relentless dive bombing.

More than halfway through the 21-day incubation period, based on behavioral observations from the blind, the nesting terns were not reacting to the UAS. Additionally, the terns were allowing gulls to fly within 15 feet of the nest without flushing. We did have a couple terns dive at the UAS during one of the higher flights, but this was right after attacking a bald eagle in the vicinity and the terns were agitated. Bald eagles are known to cause breeding failures for entire tern colonies.

With time running short we decided to make our next flights at 60 and 50 feet AGL. During a typical survey the UAS camera will take over 750 images. The images are geotagged, which means the latitude, longitude and elevation of the camera are associated with the image. The UAS flies back and forth over the survey area in a programmed flight plan so the photographs overlap each other on the sides by over 50%. The camera rapidly takes photos so each image overlaps the preceding one by 80%. The image processing software takes hundreds of overlapping images and uses the geotags and object recognition to align the photos and make a single image mosaic of the survey.

Using new technologies and approaches to help address management issues can be both exciting and aggravating. The lower altitude flights dramatically improved the images and my colleagues were confident they could definitely distinguish the two species based on bill color. The problem was the terns weren't always looking in the right direction!

Don't panic, it's not over yet. When creating the mosaic, the imaging software selects just a portion from one image out of many overlapping images to make the mosaic. So using different camera angles from unselected images of the terns, our birders were able to positively identify the species of all but a few terns from the low altitude flights.

We wrapped up our UAS surveys on June 23. Twenty-eight potential nests sites were identified from eight surveys. Terns locations identified on the orthomosaic images were given a digital marker. Terns may leave the nest to forage or they may flush due to a predator. Having multiple surveys allowed us to produce a more complete survey.

In some instances when the adult was off the nest, we were able to find the nest using the digital marker and see individual eggs and chicks. Tern chicks frequently walk off the nest into thicker cover within a few days of hatching, so these were fortunate sightings. Because the young quickly leave the nest and hide, we don't know how many fledglings survived. Next year we plan to use a thermal camera to find fledglings hiding in the grass.

All in all, the pilot testing of using UAS to survey nesting Aleutian Terns went well. We are confident these technologies will help in conservation efforts for these globetrotting birds.

Mark Laker in an ecologist at Kenai National Wildlife Refuge. Find more information about the Refuge at http://www.fws.gov/refuge/kenai/ or http://www.facebook.com/kenainationalwildliferefuge.

Assessing stream crossings for fish passage

by Emily Munter

This perched stream culvert clearly prevents salmon and other anadromous fish from migrating further upstream and would be color coded as red in the ADF&G Fish Resource Monitor.

The habitat restoration folks in the Kenai Fish and Wildlife Conservation Office had a summer mission. The challenge posed, which we chose to accept, was to identify and list all stream crossings within the twenty Kenai Mountains-to-Sea corridors on the Kenai Peninsula and evaluate as many of them as possible for fish passage.

So what exactly are Mountains-to-Sea corridors? They are twenty anadromous stream corridors that begin on federally-managed lands and pass through private lands as they flow to the sea. Our beloved Kenai River is one of the twenty, but so are the Moose, Kasilof, Fox, and Resurrection Rivers and smaller creeks including Beaver Creek and Seven Egg Creek. Combined, these corridors alone contain 55% of all stream miles on the entire Kenai Peninsula! Additionally, they present a tremendous opportunity for people to collaborate in the restoration and protection of important habitats. By giving these rivers and streams focused attention, local landowners and conservationists are ensuring that people, salmon, and many other fish and wildlife species have healthy habitats to enjoy

well into the future.

Stream crossings, and culverts in particular, really catch our attention. Surveys have shown that thousands of Alaska's culverts—think everything from under highways to under your driveway—can block movement of adult and juvenile salmon during all or portions of the year. This is a big problem not only for adults trying to migrate to optimum spawning areas, but it is also a problem for juvenile salmon that swim throughout streams on a daily basis to find food and shelter. These fish will travel hundreds to thousands of miles up and down freshwater corridors during their lifetimes.

Ensuring that fish can move unimpeded among important habitats is a critical step in supporting salmon populations and in turn all of the species and habitats that depend on them. Furthermore, if a culvert is serving as a barrier to fish, it often poses a road maintenance and public safety concern as well, particularly during flood events. Appropriately sized and placed culverts benefit the people relying on those stream crossings as well.

With help from our friends at the Kenai Watershed Forum, we visited over 60 culverted stream crossings on both sides of the Kenai Mountains from May through August this year. At each site we collected a variety of data including the type, dimensions, and condition of the culvert. We also collected data on the size and gradient of the stream, the substrate present, and the surrounding habitat characteristics. We placed minnow traps both upstream and downstream of the crossing to assess the fish species that were present in the stream at that particular time. The protocol used was developed by the Alaska Department of Fish and Game (ADF&G), the U.S. Forest Service, and others and has been in use since 2001 to assess culverts throughout Alaska.

Using the data collected, we assigned a site classification for each culvert. Site classifications could be green, gray, or red depending on the amount of fish passage provided at the location. Green culverts are those providing juvenile fish with adequate passage upstream and downstream; red culverts are those that likely don't provide passage during all or parts of the year; and gray culverts most likely serve as a barrier to passage but need additional analysis.

For example, a culvert with an outlet perched 4" or more above the stream would be classified as red (baby salmon aren't great jumpers). Another example of a red culvert would be one that is too small for the size of the stream resulting in constricted flows, which quickens the water flow making it hard for those babies to swim upstream. Should you be interested in knowing if your favorite culvert has been assessed and classified, check out the fish passage portion of ADF&G Fish Resource Monitor (http://extra.sf.adfg.state.ak.us/FishResourceMonitor/).

The data collected this summer will be submitted to the ADF&G for inclusion in the statewide fish passage database. It will also guide the Service's local habitat restoration staff as we implement the Fish Passage Program, which provides funding and staff time for projects that restore fish passage and habitat connectivity at stream crossings.

Emily Munter is a Fish and Wildlife Biologist at the Kenai Fish and Wildlife Conservation Office in Soldotna. Find more information about the KFWCO at https://www.fws.gov/alaska/fisheries/fieldoffice/kenai/ and the Fish Passage Program at https://www.fws.gov/alaska/fisheries/restoration/passage.htm.

Why northern pike are bad for the Kenai Peninsula

by Rob Massengill

An invasive northern pike removed from Stormy Lake (Nikiski) in 2011. Pike have since been eradicated there and in many other areas on the Kenai Peninsula to protect native fisheries.

The history of northern pike in Southcentral Alaska is murky, but it goes something like this. Pike are not native to Alaska south and west of the Alaska Range and were likely first introduced to Bulchitna Lake in the Susitna Drainage in the 1950s. Pike are now in more than 100 waterbodies in this Indiana-sized drainage. Pike were first documented on the Kenai Peninsula near Soldotna Creek in the 1970s and have since spread to 23 waterbodies. Pike have traveled down the west side of Cook Inlet where commercial setnetters occasionally catch them. Fortunately, the same hasn't been true for Kenai Peninsula setnetters.

So what's the big deal with having pike on the Kenai Peninsula? Here, pike are considered an invasive species, which can be defined as a non-native species that causes or is likely to cause economic or environmental harm. But pike in their native range in Alaska appear to coexist just fine with salmon and trout in places like Bristol Bay and many big Interior drainages. Intuitively, this doesn't make sense. Bear with me as I explain why invasive pike are a big deal to our local native fish.

Pike are ambush predators—they prefer relatively shallow, weedy and slow water habitat from which they dart out to catch prey. Pike are less efficient ambush predators outside this habitat. Some native fish like juvenile coho salmon and trout often utilize this same habitat making them very susceptible to pike predation. In contrast, deep or fast flowing water serves as a refuge for prey as fewer pike inhabit that niche. Looking at fish survey data from Interior Alaska where native pike are widespread, it is striking how few juvenile salmonids actually coexist with pike in the countless shallow and weedy floodplain lakes common to that region despite connectivity to anadromous rivers.

Southcentral Alaska has a lot of shallow vegetated waterbodies that for millennia were nurseries for juvenile salmonids as these fish evolved in the absence of pike. Think of the canoe routes in the Swanson and Moose River drainages or lakes in the Soldotna Creek and Beaver Creek systems—these provide spectacular habitats for native trout and rearing salmon but also for pike. In contrast, the Kenai Peninsula's glacial rivers and deep sockeye rearing lakes would likely not support large pike populations because suitable pike habitat is sparse. Similarly, the world's largest sockeye fishery in Bristol Bay coexists with native pike because pike habitat is very limited in their rearing areas.

Firsthand I've seen how fisheries can collapse when invasive pike and native fish occupy the same habitat. Northern pike completely eliminated rainbow trout, Dolly Varden, juvenile coho salmon and even threespine sticklebacks from multiple lakes in the Soldotna Creek drainage where water depths rarely exceed 25 feet. Northern pike nearly extirpated arctic char and rainbow trout in Stormy Lake (Nikiski) despite lake depths up to 50 feet. Elsewhere, invasive pike have been implicated in the collapse of valuable salmon runs like the prized king salmon of Alexander Creek that once supported a multi-million dollar fishing lodge industry, and the sockeye of Shell Lake in the Skwentna River drainage.

For the last decade, my job has focused on protecting our native fisheries from pike on the Kenai Peninsula. In most instances, eradicating pike from a waterbody is infeasible with nets alone, so we treat the water with rotenone, a plant-based pesticide, to greatly increase the likelihood of success. We have demonstrated that rotenone can be applied safely and effectively while staying within the rigorous permitting and label requirements.

Following years of pike removal, there are now only eight known Kenai Peninsula waterbodies with pike, all close to one another and often referred to as the Tote Road pike lakes. Fortunately, these lakes which are surrounded mostly by private lands, do not connect to wild salmon or trout waters. So an argument could be made for leaving these pike alone—some anglers enjoy catching them, so why remove them if they don't endanger other fish? The simple reason is those pike are a source for illegal introductions elsewhere. Soon, the Alaska Department of Fish and Game will announce public scoping meetings for the proposed eradication of invasive pike from these lakes next year. This will be an opportunity to learn more about the project and to share your thoughts.

I've overheard conversations that suggest pike are spreading more by natural mechanisms than by people intentionally releasing them. Pike eggs are sticky and are broadcast on standing aquatic vegetation around ice-out each spring. The theory is these eggs could cling to plane floats or animal legs and then fall off in nearby waterbodies and kick-start new populations. Conceivably eagles could drop a live pike into a waterbody too. Any of these unintentional mechanisms are possible but must be rare.

This summer, we confirmed pike in four new lakes on the Kenai Peninsula, some of these certainly the result of deliberate introductions. In fact, identities of individuals suspected of introducing pike were reported. It is a Class A misdemeanor to transport or release live fish in Alaska without a permit. Additionally, civil penalties would seek to recoup the costs to remove introduced pike potentially costing the culprit hundreds of thousands of dollars.

So what typically happens after invasive pike are removed? Generally, the waters are restocked by ADF&G with the wild native fish assemblage historically found there. In some cases that might be just sticklebacks, in others it could include wild juvenile salmon, rainbow trout, Arctic char, Dolly Varden or sculpins. In lakes previously stocked with hatchery fish, stocking resumes.

I frequently receive feedback from residents living on lakes where pike were removed and hear things like "…we see more birds and frogs near the lake and see fish jumping regularly…". These are observations that suggest the ecological balance and biological diversity of these lakes are being restored.

What can you do to help protect our wild fish resources from invasive pike? Probably the most useful thing is to retain and report any pike caught on the Kenai Peninsula unless it came from the known pike waters off Tote Road south of Soldotna. Reports can be made online at http://www.adfg.alaska.gov/index.cfm?adfg=invasive.report or call 1-877-INVASIV.

Finally, appreciate that pike are not inherently bad fish—pike just do what they are meant to do. Pike fishing can be a great year-round experience. However, the cost of having pike on the Kenai Peninsula is that native fish populations suffer and complete loss of some fisheries occur.

Rob Massengill, a fisheries biologist with the Alaska Department of Fish & Game in Soldotna, can be reached at 262-9368. Find more information about invasive pike at http://www.adfg.alaska.gov/index.cfm?adfg=invasivepike.main.

The Harding Icefield: A shrinking landscape on the Kenai Peninsula

by John Morton

The Harding Icefield, named after President Warren Harding who visited the Territory of Alaska in 1923, straddles the Kenai Mountains between Kenai National Wildlife Refuge and Kenai Fjords National Park.

There's something as big as the island of Maui on the Kenai Peninsula that many locals have not seen or not seen well. Unless you're a pilot, your exposure to this mystery blob has likely been constrained to the hiking trail at Exit Glacier, or perhaps to viewing the tidewater glaciers in Northwestern Fjord from a commercial tour boat, or perhaps to the edge of Skilak Glacier if you're hunting sheep or goat. These glaciers, as big as they seem, are three slivers among the more than 30 glaciers that feed off the Harding Icefield.

One of four icefields remaining in the U.S., the Harding Icefield is the largest wholly within U.S. boundaries. It covers over 700 square miles, stretching more than 50 miles from the Resurrection River southward to the divide in the Kenai Mountains between Bradley Lake and Nuka Bay. The icefield embraces Truuli Peak, the highest point in the Kenai Mountains at 6,612 feet above sea level, suggesting that the Hard-

ing is likely a mile deep in some places.

We need all that ice. It's easy to forget that the freshwater trapped there is the lifeblood of so many of our glacially-fed lakes and rivers and streams in which our salmon spawn. Meltwater from the Harding Icefield feeds the Fox River and Sheep Creek that form the headwaters of Kachemak Bay. Tustumena Glacier is the headwaters of the Kasilof River. The icefield feeds the Killey River, Skilak Lake and Russian River, all tributaries of the Kenai River. It feeds the Resurrection River at the headwaters of Resurrection Bay and the countless high-gradient mountain streams that support pink salmon before cascading into the fjords along the Gulf of Alaska.

The Harding Icefield has been melting since the Wisconsin Ice Age, known locally as the Naptowne Glaciation. At its peak, some 23,000 years ago, it completely covered the Kenai Peninsula except for a few big nunataks—the Caribou Hills, a small patch on the Tustumena benchlands, and the area around Big Indian Creek in the northwestern Kenai Mountains.

And it has been mostly melting since then with some obvious exceptions like the Little Ice Age when the northern hemisphere cooled over the five centuries leading up to the 1850s. The problem is that the Harding Icefield seems to be melting faster now. Bud Rice, at the time a University of Alaska Fairbanks graduate student, used aerial photos to estimate a 5% loss in surface area between 1950 and 1985. Over roughly that same period, other researchers estimated the average ice loss was about 70 feet, or about 0.47 meters in elevation per year. A recent paper published in *Geophysical Research Letters*, however, estimated the Harding Icefield lost 0.72 meters in elevation per year in the 1990s, a 50

Not surprisingly, this accelerating ice melt is due to rapidly warming air temperatures. But here's a weird twist to this story. There's a species of green alga (*Chlamydomonas nivalis*) that lays dormant under the snow during winter. In the spring, the algae germinate in response to increased light and meltwater, sending flagellated cells with little tails that "swim" towards the surface of the snow. Here, these algal cells lose their tails and become red due to a secondary carotenoid pigment that protects the cells from intense visible and ultraviolet radiation. This red-colored snow, often to a depth of 10 inches, is called watermelon snow or red snow. Small invertebrates like ice worms and springtails feed on this red alga.

But the salient piece to this story is that watermelon snow reflects less light than plain snow and so heats more in the summer sun. This, of course, means more meltwater and larger algal blooms, which in turn heats the snow even more.

Several Alaska Pacific University researchers set out to figure out how much this algal growth contributes to faster melting of the Harding Icefield by applying fertilizer and water to experimental plots in Kenai Fjords National Park. The fertilizer simulated increasing levels of nutrient input from atmospheric deposition. Their findings, recently published in *Nature Geoscience*, showed that watermelon snow, which covers more than a third of the icefield, increased total snowmelt by 17 percent!

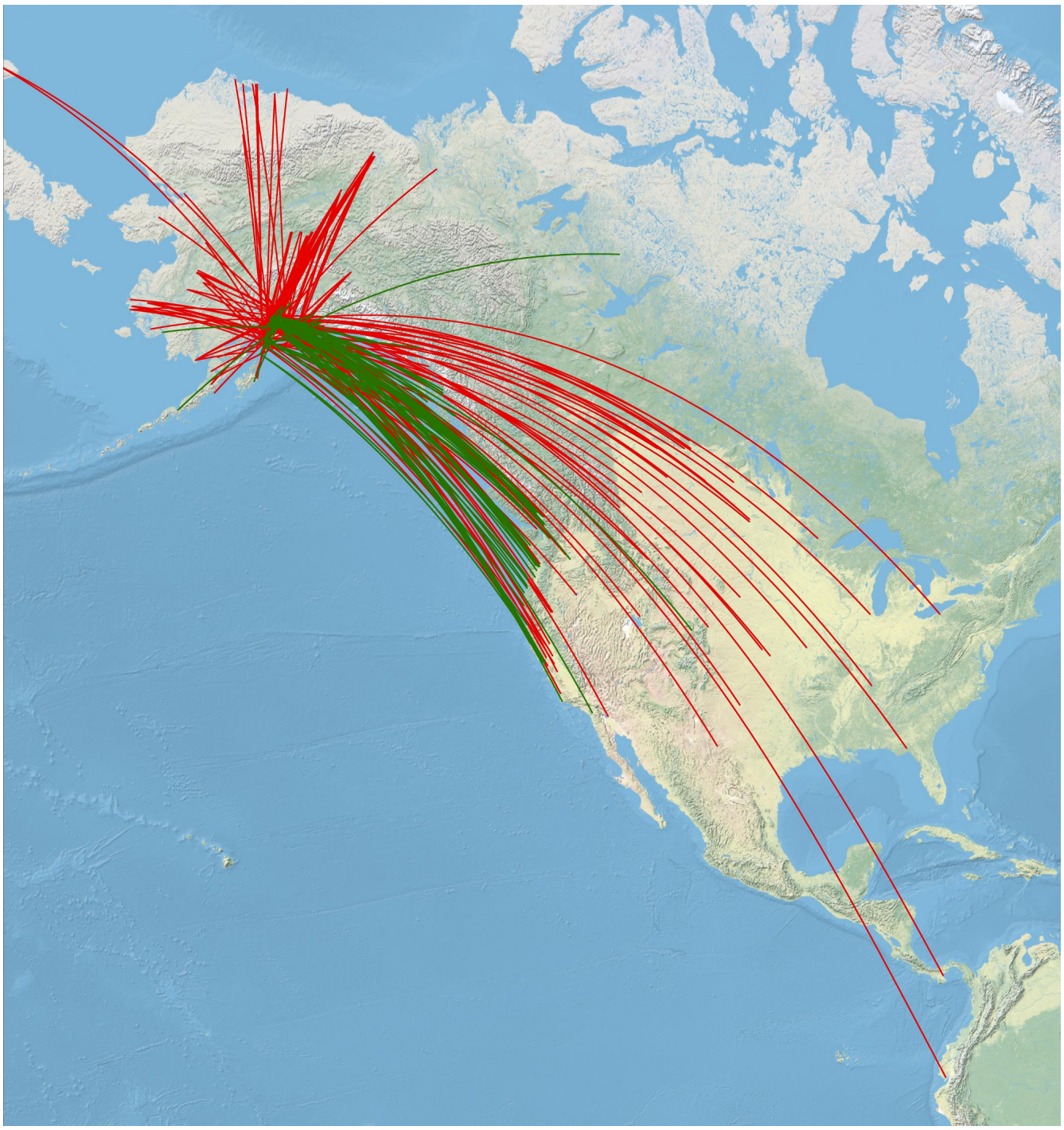
The Harding Icefield is a remnant of a much colder, prehistoric climate and becoming increasing unique as mountain glaciers and persistent snowfields disappear around the globe. In the short term, some of our larger glacial rivers like the Resurrection or the Kenai will receive more meltwater input from the Harding as our climate warms. But smaller watersheds like the Killey River are likely to become more rainwater dependent as the Harding recedes from their headwaters on the western slopes of the Kenai Mountains.

Anyways, while the Harding Icefield is in no danger of disappearing anytime soon, don't pass up an opportunity to fly over it if you haven't already. Once you see it, you'll understand why this white, vast landscape is so special.

Dr. John Morton is the supervisory biologist at Kenai National Wildlife Refuge. Find more information about the Refuge at http://www.fws.gov/refuge/kenai/ or http://www.facebook.com/kenainationalwildliferefuge.

Banded birds know no borders

by Todd Eskelin



Records of migratory birds either banded on the Kenai Peninsula and recovered elsewhere (green) or banded elsewhere and recovered on the peninsula (red). Data from USGS Bird Banding Laboratory.

One of the epic moments for any waterfowl hunter is the discovery of a bird band on the leg of one of their downed ducks. Prior to that discovery, the ducks harvested are appreciated for their beauty, the enjoyment of the hunt, and the anticipation of a delicious dinner shared among friends and family. But put a leg band on that duck and now there is a history attached to that 8 digit number and the bird has a different level of significance.

Recently, a relatively new duck hunter asked me where he would have the best chances of shooting a banded duck and if there was a particular species that would improve his chances. He had been hunting for 3 seasons and had harvested a lot of ducks and geese without a single band showing up in his bag. So I set out to answer his question and started with the Bird Banding Laboratory in Patuxent, Maryland. As a bander myself, I know all bird banding data are stored in this national database.

I was able to access the banding lab's database and filter the birds that had been encountered at some point after they were banded. Next I set the filters for all species banded on the Kenai Peninsula and encountered elsewhere or birds banded elsewhere and encountered on the Kenai. This database holds approximately 64 million banding records just since 1960 (which is as far back as the electronic version of these data go). Out of those banded birds, the lab has received encounter information on about 4 million bands or a little over 6 percent. Recovery rates are much higher for hunted species like ducks and geese than they are for non-hunted species like songbirds.

On the Kenai Peninsula, there are very few non-waterfowl related encounters. Roughly 3,700 of 3,800 band encounters that involved the Kenai Peninsula were waterfowl (97%). It was also very apparent from the data that if my waterfowl hunting friend was determined to get a banded bird, he should focus his efforts on Cackling and Canada Geese, and Mallards. Between 2014 and 2016 they accounted for 84% of the band encounters in our area.

Days later after emerging from this mountain of data, I had a strange sense of connectivity just from pouring over the data points. I wanted to go see Hays, Kansas where an American Robin was banded in January 1976 and killed by a cat in June 1977 in Kenai, AK–a distance over 2,600 miles. Then I want to go visit a banding location on the outskirts of Cleveland, Ohio, where a Myrtle Warbler was banded in October 1982. It subsequently struck a window and died in May 1983 near Beaver Loop Road after just finishing its 3,100 mile flight back to Alaska.

What did it look like at Posorja, Ecuador where a Semi-palmated Sandpiper was banded in the winter and then spotted on the Kenai Flats late the following summer on its way back to Ecuador? It didn't even get frequent flier miles for the 14,000 mile round trip flight. I even discovered that an Orange-crowned Warbler I banded near Lower Russian Lake was found dead near the Bear Creek Golf Club in Murrieta, CA.

Looking back at the waterfowl records, I found that the Kenai Peninsula truly is a melting pot. We have Mallards that were banded in Mississippi, Tennessee, Oregon, Washington and Alberta, Canada, that have all been encountered on the Kenai Peninsula. Our Cackling and Canada Geese also range from the Great Lakes to the Klamath Basin. I always thought that waterfowl passing through the Kenai Peninsula were bound for the West Coast for the winter, but it is only from the banding records that we know we have ducks from all three flyways crossing our skies.

Digging through the histories of these individual birds, I realized I felt the same draw my band seeking friend had while out hunting. It was the same excitement I had when I first started banding birds in Portland, Oregon.

In The Sand County Almanac (1949), Aldo Leopold wrote something that summarizes it perfectly for me, prompting me early in my career to work hard and achieve the skills needed to obtain a bird banding permit. "To band a bird is to hold a ticket in a great lottery. Most of us hold tickets on our own survival, but we buy them from the insurance company which knows too much to sell us a really sporting chance. It is an exercise in objectivity to hold a ticket on the banded sparrow that falleth, or on the banded chickadee that may someday re-enter your trap, and thus prove he is still alive."

Todd Eskelin is a Wildlife Biologist at Kenai National Wildlife Refuge. He specializes in birds and has conducted research on songbirds in many areas of the state. Find more information about the Refuge at http://www.fws.gov/refuge/kenai/ or http://www.facebook.com/kenainationalwildliferefuge.

Alaskan wild sheep and goats threatened by "*Movi*"

by Dom Watts

More than 30% of the Bighorn sheep population in Gardiner, Montana, died from pneumonia caused by Mycoplasma ovipneumoniae *(credit: Deby Dixon).*

Mycoplasma ovipneumoniae isn't a commonly used name in Alaska but this little pathogen has been a topic of considerable discussion and debate recently. First off, *Mycoplasma ovipneumoniae* isn't very fun to spell, so let's just call it "*Movi*."

Second, you're probably wondering just what *Movi* is and why it's important. It's a bacterium that commonly lives in the upper respiratory tracts of domestic sheep and goats, often causing mild respiratory disease. Infections in adults are typically not severe but young individuals, those in poor physical condition, or those under stress may develop acute or fatal pneumonia.

Although *Movi* infection doesn't always directly cause significant respiratory disease in domestic animals, it may predispose individuals to more serious illness. This is often caused by concurrent infections of *Movi* and other equally difficult-to-spell bacterial flora, such as *Mannheimia haemolytica* and *Pasteurella multocida*, species that naturally occur in the upper respiratory tracts of sheep and goats.

In healthy animals, these bacteria are typically held in check by the body's normal immune defenses as antibodies destroy and slow the replication of these bacteria. *Movi* infection, however, can suppress normal defense mechanisms and increase demands on an animal's immune system. Ultimately, this diminishes the animal's resistance to *Mannheimia* and *Pasteurella*

bacteria, facilitating the invasion of lung tissues and increasing the potential of fatal pneumonia.

So *Movi* can make domestic sheep and goats sick, but infected adults are often able to survive infections and can appear healthy. So what's the big deal? Sounds like an agricultural issue rather than a wildlife issue anyway, right? Well, *Movi* becomes a bigger topic when it's put in the context of wild sheep and mountain goat populations. Wild sheep and goats have little resistance to these bacteria that occur in healthy domestic sheep and goats.

Since *Movi* has not been documented in wild populations in Alaska, much of what we know about the effects of this bacterium comes from the Lower 48 and Canada. *Movi* has frequently been implicated in dramatic and large-scale die offs in Bighorn sheep populations throughout the western states, with some populations experiencing declines of 75% or more due to pneumonia outbreaks. Significantly reduced lamb survival is often commonly reported for years following outbreaks. Although we don't know much about the effects of *Movi* on Dall sheep or mountain goat populations, it seems reasonable to expect similar outcomes if *Movi* is introduced into Alaskan populations.

Like most bacteria that thrive in respiratory tracts, *Movi* is transmitted via aerosol and direct contact with infected individuals, the same way people transmit colds to each other. The end result is that *Movi* can easily be transmitted between infected domestic animals and wild populations if they come in contact. Although infected domestic stock may appear healthy, they can still spread the bacteria to wild populations. In some cases, Bighorn sheep die-offs have occurred following interactions with domestic stock, further suggesting that *Movi* can be transmitted from domestic stock to wild populations.

In Alaska, the risk of transmission between domestic stock and wild populations is much lower than in the western states where domestic grazing commonly occurs in wild habitats. One potential route for transmission of these diseases into wild populations is via hunters using pack goats while hunting in alpine habitats, which is why this activity is not allowed in Alaska. The risk of transmission between livestock near residences and wild populations in Alaska is currently unknown but interactions do occur. Given the potentially devastating impacts that might result from introductions, however, monitoring the prevalence and distribution of *Movi* in both domestic and wild populations throughout Alaska is certainly warranted.

As part of continued state-wide monitoring, mountain goats captured and fitted with radio-collars on the Kenai Peninsula during 2017 were tested for *Movi*. All goats tested were negative for *Movi* but continued monitoring is necessary, particularly on the Kenai Peninsula where the risk of introduction is greater than in many other parts of Alaska.

The bottom line? Prevention is key. So interest groups from the agricultural community, private owners, state and federal agencies, and other stakeholders are currently working to develop a plan to monitor *Movi* in domestic stock, with the goal of preventing the transmission of this and other harmful micro-organisms to wild sheep and goat populations in Alaska.

Dom Watts is a Wildlife Biologist at Kenai National Wildlife Refuge. Find more information about the Refuge at http://www.fws.gov/refuge/kenai/ or http://www.facebook.com/kenainationalwildliferefuge.

Allelopathy: plant chemical warfare

by Kyra Clark

Our native Lupine wages chemical warfare on other plants by releasing alkaloids that inhibit germination or growth.

How does one plant out compete another? How can invasive species so quickly take over well-established areas? Some plants have specialized physiological adaptations that allow them to better access resources, some have unique germination cycles that allow them to sprout earlier than others, while many nonnative invasives take advantage of not having natural predators in their new environment. There are countless ways plants compete with one another, but one of the most interesting ways plants can compete in this battle for survival is with chemical warfare.

Several native plants and numerous invasive plants are allelopathic. Allelopathy describes the process whereby plants, algae, bacteria, coral, or fungi produce and release an "allelochemical", which positively or negatively influences the germination, growth, survival, or reproduction of a neighboring organism. Although allelopathy has a broad definition, it is generally used when one plant negatively affects nearby plants. This process is different from resource competition, but it does lead to reduced competition from nearby plants.

Allelopathic plants vary in the chemical compounds they use, how these compounds are formed, where they are stored, how they are released, and their modes of action in target plants. All allelochemicals, however, are secondary metabolites (not required for growth, development, or reproduction) and once released affect the survival or health of neighboring organisms. Allelochemicals are rarely auto-toxic, mean-

ing plants do not release enough toxic compounds to negatively affect its own growth.

Plants store allelochemicals in a single location, multiple locations, or throughout the entire plant. They are often found in the roots, leaves, pollen or buds. Allelochemicals are introduced into the environment by being exuded (released) from roots, released from decaying plant matter, leached from the plant, or volatilized (become a gas).

Allelochemicals can be classified under several groups of compounds. These groups describe an infinite number of compounds found in plants but only a select few within each group are actually allelopathic. Over the years there has been a lot of research on allelochemicals, but because they can be difficult to isolate and may have several functions, it is hard to determine if a compound is truly allelopathic.

Here in Alaska, there are both native and invasive allelopathic plants. Lupines (*Lupinus* sp.) are a familiar plant to most Alaskans and all lupine species release an alkaloid allelochemical. The alkaloid group includes recognizable compounds like morphine, nicotine, and caffeine. Allelopathic alkaloids can target multiple sites that inhibit seed germination or growth by impeding certain enzyme functions, photosynthesis, respiration, or DNA/RNA processing enzymes.

The highly invasive Spotted Knapweed (*Centautea stoebe*) uses an allelochemical within the flavonoid group of compounds. Allelopathic flavonoids generally inhibit seed germination and limit root or shoot length by blocking the H+-ATPase enzyme, the electron transport chain, or oxygen uptake by mitochondria. Spotted Knapweed exudes this flavonoid from its roots, which then leads to death of the root systems in nearby plants.

Another invasive plant that exudes allelochemicals from its roots is Garlic Mustard (*Allaria petiolafa*). Garlic Mustard releases a type of glucosinolate compound that, once released, becomes volatile and fills soil pores as a gas where it then acts on neighboring seeds. Glucosinolates can either be volatile or nonvolatile but, either way, they inhibit seed germination by targeting the enzymes necessary for glycolysis and respiration.

Quackgrass (*Elymus repens*), a common grass, releases a hydroxamic acid. Hydroxamic acids are usually exuded from roots (which is what quackgrass does) or released from degrading plant parts. These compounds inhibit seed germination and growth by blocking H+-ATPase enzyme and root growth. Hydroxamic acids often work with phenolic compounds, another group containing allelochemicals. However, phenolic compounds may not be true allelochemicals as they have a generalized cytotoxicity when in mixtures, but individual phenolic compounds are poorly cytotoxic when isolated.

The last three common groups of compounds that contain allelochemicals are quinones (e.g., Black Walnut), terpenoids (e.g., Rosemary) and polyacetylenes (e.g., Russian Knapweed). All of these groups use different modes of action to inhibit seed germination or growth.

One invasive species that has notoriety in Alaska is Orange Hawkweed (*Hieracium aurantiacum*). This hawkweed is pollen-allelopathic, meaning that allelochemicals are carried in wind-dispersed pollen and fertilized seeds, a strategy that allows it to rapidly establish in new areas. Meadow Hawkweed (*Hieracium caespitosum*) may also be pollen-allelopathic and/or may release allelochemicals in their decaying leaves. Our native Cottonwood is also allelopathic, releasing allelochemicals in decaying leaves that inhibit herbaceous seed growth nearby.

Both native and nonnative invasive species use allelopathy to their advantage. Because native plants co-evolve, the effects of native allelopathy seem to be more limited, perhaps because immunity or resistance becomes a rapidly-selected trait. On the other hand, when nonnative invasive allelopathic species enter a new environment, they quickly spread as native plants have not adapted to counteract these new allelochemicals.

The fact that certain plants produce specific compounds with the sole intention of harming neighboring plants for their own gain is both ruthless and fascinating. Occasionally the plants that appear the most robust and best suited for an environment are not the ones that survive—sometimes survival of the fittest come down to the production and release of tiny compounds. That's right, plants just got a little more interesting.

Kyra Clark is a seasonal biological technician at Kenai National Wildlife Refuge. Find more information about the Refuge at http://www.fws.gov/refuge/kenai/ or http://www.facebook.com/kenainationalwildliferefuge.

Tall woolly-heads: what are they doing here?

by Matt Bowser

Tall woolly-heads off of Mystery Creek Road, August 2, 2017.

Every summer in the course of our work on the Refuge we biologists inevitably collect plants to be identified later. We arrange specimens in folded newspaper in a plant press in which they are compressed and dried.

Last week as biological technician Kyra Clark and I opened up a press and started looking through specimens from last summer, we pulled out a plant that I could not identify. It was a small, fuzzy, unfamiliar plant I had picked up from Mystery Creek Road where it had been abundant around puddles. Even after scrutinizing it under the microscope and consulting what books I had, I could not figure out which family this plant belonged to.

I posted photos of the plants on iNaturalist.org, a website for sharing observations of living things. Members of the community identified them as tall woolly-heads, also known as meadow woolyheads, tall woolly-marbles, or *Psilocarphus elatior*. Native to the Pacific Northwest, these are small, short-lived plants that live almost exclusively on muddy, drying margins of temporary pools and puddles where few other plants grow.

This was a surprising find, the farthest north and

farthest west record for the genus *Psilocarphus*, 560 miles northwest of the nearest known population on Cichagof Island, Southeast Alaska. Found by the Forest Service in 2012, it appeared that this population had been introduced through logging activities. It was considered to be a weed, but the population does not appear to be spreading and may even be decreasing. No action has been taken to remove it.

A few hundred miles to the south in British Columbia, *Psilocarphus elatior* is considered to be native and critically imperiled, with only five small populations known. Nationally, it is classified as endangered in Canada, but it is not considered to be of conservation concern in the U.S.

Finding Tall woolly-heads on the Kenai raises two related questions. How did they get here and what should be done about it? As to how they got here, there are only three possibilities: they could have been brought here by human activities, they could have arrived by natural means, or they may have been here for a long time. Woolyheads are not especially good at getting around, with no special structures on their seeds for dispersal by wind or animals. It has been speculated that woolly-head seeds might be transported on muddy feet of waterfowl, but this has not been confirmed.

It seems likely that tall woolly-heads arrived on the Kenai Peninsula recently. We have been doing botanical work in the Mystery Creek area since at least the late 1990s. If it was there, someone should have noticed this peculiar, woolly plant even though it is small.

Probably, seeds of tall woolly-heads were transported here with equipment, vehicles, feed, or manure from the lower 48. Mystery Creek Road has a relatively long history of human disturbance beginning with construction in 1960 and continuing with maintenance since that time. The area has been popular for hunting since at least 1964, accessed mainly by four-wheel-drive vehicles. Horses are also used to travel this part of the Refuge. Controlled burn operations have been conducted in this area since the 1990s.

Even with Mystery Creek Road's history, it seems odd that tall woolly-heads would show up there before being found at more highly-disturbed areas on the Kenai Peninsula. It is possible that waterfowl brought *Psilocarphus* here. If this is the case, we would expect to find it on muddy pool margins well away from roads.

I intend to check for woolyheads at other likely locations on the Peninsula that might give us clues as to how they arrived and how they are fitting into our Kenai Peninsula system. For now I added *Psilocarphus elatior* to the Refuge's checklist as an exotic species because our best guess is that it was introduced recently by humans. Would it be appropriate to label this species as exotic if it had arrived here via waterfowl or should this be considered natural?

Unlike *Elodea* and northern pike, examples of North American species brought to the Kenai Peninsula by humans which we consider to be injurious, tall woolly-heads pose little threat because they thrive only in particular habitats and are not expected to have much of an effect on other species. The only interaction we have a guess about is that woolyheads may serve as some small portion of the diet of snowshoe hares because we know that cottontails eat another species of *Psilocarphus* in California.

Whenever and however they arrived, it appears that there are plenty of woolyheads on Mystery Creek Road now. The second question remains: what, if anything, should be done? If they were brought here recently by people, then tall woolly-heads could be added to our list of weeds to be controlled. On the other hand, this species is endangered in other parts of its range, so it might be best to conserve it.

Should our response depend on when and how a species arrived? Should it depend on whether or not we expect a newly-arrived species to be injurious?

Matt Bowser serves as Entomologist at the Kenai National Wildlife Refuge. *Matt thanks Justin Fulkerson and others on the AkRarePlant-L mailing list for helpful information on this topic. Find more information at http://www.fws.gov/refuge/kenai/ or http://www.facebook.com/kenainationalwildliferefuge.*

Thanks to those who serve at the Refuge

by Steve Miller

The Youth Conservation Corps crew takes a break from their work on the Hideout Trail.

Each year—and 2017 is no exception—I look back and am thankful for the many volunteers and seasonal employees without whom the Kenai National Wildlife Refuge could not keep up with the needs of our visitors. During the busy summer months the Refuge staff more than doubles in size with the addition of our seasonal employees and volunteers. For many of our visitors, the face they see wearing the refuge uniform will be a seasonal. Whether it is the person coming through the campground collecting fees, leading an interpretive walk or summer camp or working in the visitor center, our seasonal employees assist us in accomplishing all of these things.

We are blessed in that many of our seasonals have been coming back year after year. Every spring these experienced hands assist in organizing the new hires and coordinating the work of our many volunteers who are either new to Alaska or new to the Refuge.

In 2017 we had eleven volunteers from Wilderness Trails that assisted in rerouting a section of the Cottonwood Trail in Kenai Wilderness. A group of enthusiastic volunteers from the Soldotna Church of the Nazarene helped us resurface the Keen Eye Trail. A contingent from the Friends of Alaska Refuges paddled with us in the Swan Lake Canoe System and assisted in clearing portages. A volunteer from the Local Chapter of the Back Country Horsemen of America, assisted by family, transported equipment and supplies along the Hansen Horse Trail and Bear Creek Trail for our trail crew. In addition, we had volunteers who assisted in keeping the visitor center operational and our campgrounds organized. All of these individuals, along with the Kenai Watershed Forum Stream Watch volunteers and others that I have not mentioned, kept up with the needs of our numerous visitors.

Again in 2017 we hired five students from the local community in our Youth Conservation Corps Program. Hopefully they will all have fond memories of

the work they helped us accomplish on Bear Mountain Trail, Hideout Trail, Kenai River Trail, Swan Lake Canoe System, and Dolly Varden and Nurses Public Use Cabins. If not all these memories are fond, at least they should have some interesting stories to tell. Our YCC students completed all these projects with an amazing attitude and without any accidents, maintaining the outstanding record of the Refuge's preceding YCC crews.

YCC leader Nick Longobardi looks over Skilak Lake from the Vista Trail.

Our seasonal trail crew seemed to be extremely busy this year. All of the trail crew are also collateral duty wildland firefighters and each year some of them travel on fire assignments in Alaska or the lower 48. This year all of them served one or more fire assignments. With our long growing season this made it challenging to keep up with the expectations of our hiking visitors. This summer we had a big wind event while the trail crew all happened to be out on a fire assignment at the same time. Our maintenance staff stepped up and cleared downed trees from our busiest trails.

This wasn't the only time this year where permanent staff worked outside of their normal duties. To save money on a streambank stabilization project at the Russian River Ferry, we constructed the wooden rail fence in-house and staff from all the different programs got dirty digging holes. While the maintenance staff dug more than did the other staff members, all the additional help allowed us to accomplish this project and do it cost-effectively.

With all of our staff and volunteers driving the Peninsula's roads, floating or motoring on the Kenai River, hiking and flying across the Refuge and running chainsaws and heavy equipment, I am thankful that we were able get our work done safely once again. We put our greatest effort into ensuring that our staff and volunteers are able to work safely and efficiently so that they may not only provide for the needs of our visitors, but, more importantly, go home each night (or at the end of the season) to be with their families.

For those individuals and families who entrusted themselves or their family members to us as volunteers, seasonal employees or permanent staff: Thank You! We could not do what we do without you. With your help we look forward to doing it even better in 2018.

Steve Miller is the Deputy Refuge Manager at the Kenai National Wildlife Refuge. Find more information about the Refuge at http://www.fws.gov/refuge/kenai/ or http://www.facebook.com/kenainationalwildliferefuge.